PUBLIC OPINION UPON PUBLIC BUILDINGS.

A GREAT revolution has been produced in the art of Architecture in our own day. Many of our readers, as well as ourselves, can remember the time when a few persons, some of whom are still living and not always designated by very honourable terms, were supposed to be almost the personifications of taste; and when to have expressed a doubt of the propriety of the deference with which their opinion was treated, would have brought the unlucky disputant as much scorn as he would now be treated with who should venture to quote their works as worthy of imitation. Men were in those days governed by authority, and having invested some individual with an imaginary quality, for the most part created by the smiles of fortune, they passively admitted the excellence of all that he said, and admired all that he did. Impudance and good-luck were the most available qualities for honour, as they are still for wealth. But it has unfortunately happened, for their own self-complacency and ease, that some of the professional men of the old school have lived to see a new era in art, opposed to their authority and doubtful of their genius. There is in the public mind of the present day a great independence of opinion, and a determination to judge from examination rather than from fashion. In works of art, men will not now consent to be either led or driven to a conclusion by the authority of a great name, but they look with the same unprejudiced eye upon the design of an unknown as upon the work of one whose name is familiar to their ear. It is the thought, or the act, that is appreciated, not the man. We might, were it necessary, give numerous instances of this. Great efforts have been made to convince the world that Buckingham Palace and the National Gallery are fair specimens of British taste, but men will not believe that either the one or the other deserves more than an unconditional reprobation. Whether the majority of even the thinking people have been sufficiently instructed to give any value to the opinion thus unhesitatingly expressed, it is not for us to determine; but no one can have failed to observe a remarkable acuteness of observation, a ready appreciation of utility, and a quick perception of defective detail, whether in form or proportion. With such qualities, men soon become judicious and acute critics, and their opinions cannot long be treated with disdain or levity.

The anxiety now felt, and frequently expressed, for the suitable design and construction of public buildings, is a good evidence that Architecture is more appreciated, and it may also be presumed that it is better understood. This newly-created feeling may be sometimes inconvenient to those in authority, and to the professional men, of a certain class, employed by them, but it must not be slighted, much less treated with scorn or contempt. The anxiety is felt by those who are conscious that they have a right to the expression of an opinion, and who, from a mortifying consciousness that the national taste has been caricatured and held to scorn by the expenditure of public money, are convinced that their interference is not unnecessary, and cannot be productive of more mischief than their apathy. The patronized architects, we fear it must be admitted, are behind the public in their conceptions of what a British national structure should be. It would be unfair to expect a design, or even a description of what he would have, from the idler who, after examining one of our modern structures, exclaims, "Well! I cannot tell you what the building should have been, but this is not what I expected. Taken altogether, it gives me no idea of the purpose for which it is intended, nor of the great nation for whom it was erected; and when examined minutely, the parts do not seem to be consistent with each other." The probability is, that the uneducated man who thus passes unconsciously the strongest condemnation upon the building he criticises, only requires six months' instruction in drawing and the principles of the art to have produced a better design,—a more worthy national structure.

From what we have stated, it will appear that we entertain an opinion not unfavourable to the ability of the public to give judgment upon a question of taste. But whether capable or not, the right is assumed and exercised, and from the decree there is no appeal. It may be mortifying to the pride of some of the architects of the old school, to find that they are no longer considered capable of occupying the judgment-seat, and still more so that they must be amenable to the power which, though once delegated to them, is now assumed and wisely exercised by its lawful proprietors. There is still some show of resistance to this authority, but the struggle will be unavailing—the judgment may be delayed, but it will be unprejudiced and final.

These remarks have been suggested by the inquiry, "What is to be the design for the British Museum?" Sir Robert Smirke has been for many years engaged, as is well known, upon this building, and it has now become a sort of retiring pension. The works are understood to be sufficiently advanced for the consideration of what is to be the principal front, and this momentous question having been decided by those in authority, the public demands a view of the design that has been chosen. This demand is silently and contemptuously disregarded by the architect, as though it were an impertinent interference. Sir Robert Smirke is quite aware that the public opinion is not unanimously in favour of his style of architecture. The cold and lifeless, though well-drawn forms with which he has converted the British Metropolis into a sort of architectural quakerism, do not please every eye. Carefulness and caution are written upon every structure designed by Sir Robert Smirke, but no one has ever yet imagined that he could discover in them the emblem of genius. But it is not our business at the present moment to criticise the style of this successful architect, the duty we have to perform between him and the public is to insist upon the propriety of the demand for a publication of the design. We would not unnecessarily wound the feelings of any man, and especially of one who, although now unequal to the requirements of the age, was once as far before his contemporaries, and has done much to improve the public taste. With many miserable specimens of the designs usually adopted under government patronage daily before them, and painfully affected by the cold and forlorn aspect of Smirke's best buildings, it is not surprising that the inhabitants of the metropolis should express some anxiety to know whether the British Museum is to be a building worthy of the age and nation. To delay any longer the publication of the design will be considered a tacit admission that the architect is in fear of public censure, and conscious of his own inability to meet the wants of the age.

TIMBER OF NORTH AMERICA.

[THE inquiries we have frequently received for Mr. David Stevenson's valuable paper on the "Building Materials of North America," have induced us to print that part of it which relates to American timber, as a large number of our readers are probably unacquainted with the essay.—Ed.]

The forests, to the British eye, are perhaps the most interesting features in the United States, and to them the Americans are indebted for the greater part of the materials of which their public works are constructed. These forests are understood to have originally extended, with little exception, from the sea-coast to the confines of the extensive prairies of the western states; but the effects of cultivation can now

be traced as far as the foot of the Alleghany Mountains, the greater part of the land between them and the ocean having been cleared and brought into cultivation. It is much to be regretted that the early settlers, in clearing this country, were not directed by a systematic plan of operations, so as to have left some relics of the natural produce of the soil, which would have sheltered the fields and enlivened the face of the country, while at the same time they might, by cultivation, have been made to serve the more important object of promoting the growth of timber. Large tracts of country, however, which were formerly thickly covered with the finest timber, are now almost without a single shrub, everything having fallen before the woodman's axe; and in this indiscriminate massacre, there can be no doubt that many millions of noble trees have been left to rot, or, what is scarcely to be less regretted, have been consumed as firewood. This work of general destruction is still going forward in the western states, in which cultivation is gradually extending; and the formation of some laws regulating the clearing of land, and enforcing an obligation on every settler to save a quantity of timber, which might perhaps be made to bear a certain proportion to every acre of land which is cleared, is a subject which I should conceive to be not unworthy of the attention of the American Government, and one which is intimately connected with the future prosperity of the country. But should population and cultivation continue to increase in the same ratio, and the clearing of land be conducted in the same indiscriminate manner as hitherto, another hundred years may see the United States a *treeless* country. The same remarks apply, in some measure, to our own provinces of Upper and Lower Canada, in many parts of which the clearing of the land has shorn the country of its foliage, and nothing now remains but blackened and weather-beaten trunks.

The progress of population and agriculture, however, has not as yet been able entirely to change the natural appearance of the country. Many large forests and much valuable timber still remain both in Canada and in the United States; the Alleghany Mountains, as well as other large tracts of country towards the north and west, which are yet uninhabited, being still covered with dense and unexplored forests.

The timber trade of the United States and of Canada, from the quantity of wood which is required for home consumption and exportation, is a source of employment and emolument to a great mass of the population. It is carried on to a greater or less extent on all American rivers, but the Mississippi and the St. Lawrence are more especially famous for it. The chief raftsmen, under whose direction the timber expeditions on these rivers are conducted, are generally persons of great intelligence, and often of considerable wealth. Sometimes these men, for the purpose of obtaining wood, purchase a piece of land, which they sell after it has been cleared; but more generally they purchase only the timber from the proprietors of the land on which it grows. The chief raftsman and his detachment of workmen repair to the forest about the month of November, and are occupied during the whole of the winter months in felling trees, dressing them into logs, and dragging them with teams of oxen on the hardened snow, with which the country is then covered, to the nearest stream. They live during this period in temporary wooden huts. About the middle of May, when the ice leaves the rivers, the logs of timber that have been prepared and hauled down during winter, are launched into the stream, and being formed into rafts, are floated to their destination. The rafts are furnished with masts and sails, and are steered by means of long oars, which project in front, as well as behind them: wooden houses are built on them for the accommodation of the crews and their families. I have several times, in the course of the trips which I made on the St. Lawrence, counted upwards of thirty men working the steering oars of the large rafts on that river, from which some idea may be formed of the number of their inhabitants. Those rafts are brought down the American rivers from distances varying from one hundred to twelve hundred miles, and six months are often occupied in making the passage. When it is at all possible, they moor them during the night in the still water at the edge of the river, but when this cannot be done, they continue their perilous voyage in the dark, exhibiting lights at each corner of the raft to warn vessels of their approach to them. The St Lawrence rafts vary from 40,000 to 300,000 square feet, or from about one to no less than seven acres in surface, and some of them contain as much as £5000 worth of timber. If not managed with great skill, these unwieldy specimens of naval architecture are apt to go to pieces in descending the rapids, and it not unfrequently happens that the labour of one, and sometimes two seasons, is in this way lost in a moment. An old and experienced raftsman, with whom I had some conversation on board of one of the St. Lawrence steamers, informed me that he, on one occasion, lost £2500 by one raft, which grounded in descending a rapid, and broke up. He said the safest size for a raft was from 40 000 to 50,000 square feet, or about one acre, and that five men were required to work a raft of that size.

The species of forest trees indigenous to different countries, is an interesting subject connected with vegetable physiology. There are said to be about thirty forest trees indigenous to Great Britain, which attain the height of thirty feet; and in France there are about the same number. But, according to the best authorities, there are no less than 140 species which attain a similar height indigenous to the United States.

To notice each of these numerous species, whose timber is employed by the Americans in the arts, even if I were able to do so, would greatly exceed the limits to which I am restricted by the nature of the present communication, and I shall therefore only make a few remarks regarding those timbers which are most highly prized, and most extensively used in the ship carpentry and public works of the country.

The first which I shall notice is the Live Oak (*Quercus virens*), so named because it is an evergreen, its leaves lasting during several years, and being partially renewed every spring. It grows only in the southern states, and is one of the most valuable of the American timbers. The duty imposed by our government on wood from the United States, prevents its importation into Britain, and as live oak grows only in the United States, and is not found in Canada, it consequently never reaches this country as an article of commerce; the whole produce being consumed by the Americans themselves in shipbuilding. Its specific gravity is equal to, and in some cases greater than, that of water, and it is used along with white oak and cedar for the principal timbers of vessels. The climate, according to an American authority, becomes mild enough for its growth near Norfolk, in Virginia, though at that place it is less multiplied and less vigorous than in more southerly latitudes. From Norfolk it spreads along the coast for a distance of 1500 or 1800 miles, extending beyond the mouths of the Mississippi. The sea air seems essential to its existence, for it is rarely found in the forests upon the mainland, and never more than fifteen or twenty miles from the shore. It is most abundant, most fully developed, and of the best quality, about the bays and creeks, and on the numerous fertile islands which lie scattered for several hundred miles along the coast. The live oak is generally forty or fifty feet in height, and from one to two feet in diameter, but it is sometimes much larger, and its trunk is often undivided for eighteen or twenty feet. There can be little doubt, from its great density and durability, that this is one of the finest species of oak that exists, surpassing even that for which Great Britain is so famous. Its cultivation has been tried in this country without success; but could it be imported, it would be found admirably suited for the construction of lock-gates and other engineering works, for which hard and durable timber is required, and for which English or African oak is generally used.

The White Oak (*Quercus alba*) is the species of which so much is imported into this country. It is known by the name of "American oak," but it is a very different and much inferior wood to the live oak of the United States, which I have just described. It is also much more widely distributed, and occurs in much greater quantity, than the live oak. It is very common throughout the northern states and in Canada, from whence it is exported to this country. It attains an elevation of seventy or eighty feet, with a diameter of six or seven feet. It is known by the whiteness of its bark, from which it derives its name, and from a few of its leaves remaining on the branches in a withered state throughout the winter. The wood is of a reddish colour, and in that respect is very similar to English oak. But it is generally acknowledged to be greatly inferior to it in strength and durability. It is very straight in the fibre, however, and can be got in pieces of great length and considerable scantling—properties which, for certain purposes, make it preferable to the British oak. It is much used in ship-building, and also for the transverse sleepers of railways. There are many other oaks in the United States, but the two I have mentioned are those most in use.

The pines are perhaps the next woods in importance to the oaks. The species of those are also very numerous, and I shall only mention one or two of the most important of them.

The White or Weymouth Pine (*Pinus strobus*), is widely distributed both in the United States and in Canada, and is exported to Britain

in great quantities from the latter country. It is the tallest tree of the American forest, having been known, according to Michaux, to attain the height of 180 feet. The wood has not much strength, but it is free from knots, and is easily wrought. It is very extensively employed in the erection of bridges, particularly *frame* and *lattice* bridges, a construction peculiar to the United States, and very generally adopted in that country, which I have described in detail elsewhere. For this purpose it is well fitted, on account of its lightness and rigidity, and also because it is found to be less apt to *warp* or *cast* on exposure to the atmosphere than most other timbers of the country. It is much used for the interior fittings of houses, and for the masts and spars of vessels.

The Yellow Pine (*Pinus mitis* or *variabilis*) occurs only in the southern and middle states, and is not found in Canada, and therefore does not reach this country, the wood known by that name in Britain being the *Pinus resinosa*. It attains the height of 50 or 60 feet, with a diameter of 2 or 3 feet, and is the timber which the Americans employ in greatest quantity for the masts, yards, booms, and bowsprits of their vessels. A large quantity of it is annually consumed for this purpose in the building-yards of New York, Philadelphia, and Baltimore.

The Red Pine (*Pinus resinosa*) is the only other of the pine species that is much used. It occurs in great plenty in the northern and middle states, and in Canada, from whence it is exported in great quantity to this country, and it is known to us by the name of "American yellow pine." It attains the height of 70 or 80 feet, with a diameter of two feet, and is remarkable for the uniform size of its trunk for two-thirds of its height. Its name is derived from the redness of its bark. The wood, owing to the resinous matter it contains, is heavy; and is highly esteemed for naval architecture, more especially for decks of vessels, both in this country and in America.

The Locust (*Robinia pseud-acacia*), from the beauty of its foliage and the excellent qualities of its timber, is justly held in great esteem in America. It abounds in the middle states, and in some situations attains the height of 70 feet, with a diameter of 4 feet. The wood of the locust tree is of a greenish yellow colour, marked with brown veins, not unlike the laburnum of this country. It is a close-grained, hard, and compact wood, and is of great strength. It is used, along with live oak and cedar, for the upper timbers of vessels, and is almost invariably used for treenails, to which it is well adapted. It is also employed in some parts of the country as transverse sleepers for railways. Its growth being chiefly confined to the United States, it is not imported into Britain. It is one of the very few trees that are planted by the Americans, and may be seen forming hedge-rows in the highly cultivated parts of Pennsylvania.

The Red Cedar (*Juniperus Virginiana*) is another valuable wood, the growth of which is confined to the United States. In situations where the soil is favourable it grows to the height of 40 or 50 feet, with a diameter of 12 or 13 inches. This wood is of a bright red colour; it is odorous, compact, fine-grained, and very light, and is used, as already stated, in ship-building, along with live oak and locust, to compensate for their weight. It is considered one of the most durable woods of the United States, and being less affected by heat or moisture than almost any other, it is much employed for railway sleepers. I remember, in travelling on some of the railways, to have been most pleasantly regaled for miles together, with the aroma of the newly laid sleepers of this wood. It is now, however, becoming too scarce and valuable to be used for this purpose

The White Cedar (*Cupressus thyoides*) and the Arbor Vitæ (*Thuja occidentalis*) are employed for sleepers and other purposes to which the red cedar is applied, but the latter is preferred when it can be obtained.

The only other tree which I shall notice is the Sugar Maple (*Acer saccharinum*), which occurs in great abundance in Canada and the northern states. It attains the height of 50 or 60 feet, and is from 12 to 18 inches in diameter. The wood of this tree is soft, and when exposed to moisture it soon decays. It is very close-grained, and when cut in certain directions is remarkably beautiful, its fibres, owing to their peculiar arrangement, producing a surface variegated with undulations and spots. It is also susceptible of a very high polish. These qualities tend to render it a valuable acquisition to the list of American woods for ornamental purposes, for which it is very generally employed, and is well known in this country by the name of "Bird's Eye Maple." The wood of the Red-flowering Maple (*Acer rubrum*) is also employed for ornamental purposes, and is generally known by the name of "Curled Maple." The cabins of almost all American-built vessels are lined with these woods, or with mahogany inlaid with them, and they are also much used for making the finer parts of the furniture of houses.

The property of the sugar maple, however, from which it derives its name, is of perhaps more importance in a commercial point of view than its use as timber. I allude to its property of distilling a rich sap, from which sugar is largely manufactured throughout the United States. From two to four pounds of sugar can be extracted annually from each tree without hurting its growth. I had an opportunity of making some inquiries regarding this simple process when on the banks of the river Ohio, where I saw it in progress. One or two holes are bored with an auger, at the height of about two feet from the ground, and into them wooden tubes, formed of the branch of some soft hearted tree hollowed out, are inserted. The sap oozing from the maple flows through the tubes, and is collected in troughs. It is then boiled until a syrup is formed of sufficient strength to become solid on cooling, when it is run into moulds and is ready for use.

Such is a brief notice of some of the principal timbers of the United States, which, from their great abundance and variety, are suitable for almost every purpose connected with the arts, and thus serve in some degree to compensate for the want of stone, while at the same time they afford great advantages for the prosecution of every branch of carpentry, an art which has been brought to great perfection in that country. Many ingenious constructions have been devised to render timber applicable to all the purposes of civil architecture, and in no branch of engineering is this more strikingly exemplified than in bridge-building. Excepting a few small rubble arches of inconsiderable span, there is not a stone-bridge in the whole of the United States or Canada. But many wooden bridges have been constructed. Several of them, as is well known, are upwards of a mile and a quarter in length, and the celebrated Schuylkill Bridge at Philadelphia, which was burnt about two years ago, but was in existence when I visited the country, consisted of a single timber-arch of no less than 320 feet span. Canal locks and acqueducts, weirs, quays, breakwaters, and all manner of engineering works have been erected, in which wood is the material chiefly employed; so that if we characterize Scotland as a stone and England as a brick country, we may, notwithstanding its granite and marble, safely characterize the United States as a country of timber.

I shall only, in conclusion, very briefly allude to the *appearance* of the American forests, of which so much has been written and said, and on this subject I may remark, that it is quite possible to travel a great distance without meeting with a single tree of very large dimensions; but a traveller, I think, cannot fail very soon to discover that the average size of the trees is far above what is to be met with in this country. I measured many trees, varying from 15 to 20 feet in circumference, and the largest which I had an opportunity of actually measuring was a Button-wood tree (*Platanus occidentalis*) on the banks of Lake Erie, which I found to be twenty-one feet in circumference. I saw many trees, however, in travelling through the American forests, which evidently far exceeded that size, and which my situation, as a passenger in a public conveyance, prevented me from measuring.

M. Michaux, who has written on the forest trees of America, in speaking of their great size, states, that on a small island in the Ohio, fifteen miles above the river Muskingum, there was a button-wood tree, which, at five feet from the ground, measured 40 feet 4 inches in circumference. He mentions having met with a tree of the same species on the right bank of the Ohio, thirty-six miles above Marietta, whose base was swollen in an extraordinary manner; at four feet from the ground it measured 47 feet in circumference, giving a diameter of no less than 15 feet 8 inches; and another of nearly as great dimensions is mentioned by him as existing in Genesse; but these trees had perhaps been swollen to this enormous size from the effects of some disease. He also measured two trunks of white or Weymouth pine, on the river Kennebec, in a healthy state, one of which was 154 feet long, and 54 inches in diameter, and the other was 142 feet long, and 44 inches in diameter, at three feet from the ground. M. Michaux also measured a white pine which was 6 feet in diameter, and had reached probably the greatest height attained by the species, its top being 180 feet from the ground. It is difficult for an inhabitant of our island, without having seen the American forests, to credit the statements which have been made by various authors, as to the existence of these gigantic trees of 180 feet in height (being about 40 feet higher than Melville's monument, St. Andrew Square, in Edinburgh); but such trees undoubtingly do exist. Mr.

James Macnab of the Royal Botanic Garden, in a paper on the local distribution of diffent species of trees in the native forests of America, mentions having measured numerous specimens of the *Pinus Strobus* in Canada, which averaged 16 feet in circumference, and 160 feet in height; andone specimen which had been blown down, and of which the top had been broken off, measured 88 feet in length, and even at this height was 18 inches in diameter.

The ascent of the sap in trees is a subject which has long occupied the attention of physiologists. Some difference of opinion, however, exists regarding it, and hitherto it is believed no definite conclusions have been arrived at;—and although not strictly connected with the subject of this paper, I may be excused for remarking, that the quantity of the sap required to sustain such enormous trees as these I have been describing, and the source and nature of the power by which a supply of fluid is raised and kept up, at the height of 180 feet from the ground, are inquiries which, could they be satisfactorily solved, would form most interesting and instructive additions to our knowledge regarding vegetable physiology.

MR. STEWARD'S PLAN FOR A HARBOUR OF REFUGE AT DOVER.

We have been favoured by Mr. Steward with a copy of his Report on a plan suggested by him for making a Harbour of Refuge at Dover. In the absence of drawings we are at present unable to give an opinion of its suitability, but we insert with pleasure the following description by "A Practical Engineer."

Mr. Stewart's plan for enclosing the bay, so universally approved of, annihilates all the dangerous features that the government plan and many others are fraught with, which is effected by the peculiar direction of the piers. The plan embraces two—a western and eastern pier—to be carried out from the shore; the former from Cheeseman's Head, and the latter mid-way from South Foreland to Castle Jetty, curving round, and enclosing the bay, the direction of which, and that of the shore, forming almost an elliptical area of nearly 450 acres, leaving an entrance of 500 feet at S.E. Considerable skill and judgment is here manifested in planning the west pier: so that the part nearest the shore forms a curve, making an acute angle with the shore to invite the wave, impinged by the prevailing winds, to arrest and lodge that uncontrollable enemy, the shingle, there. The harbour is designed to be extensive, but yet snug, uninterrupted by prevailing winds, with an entrance of a judicious width. It may be here remarked, that the government plan embraced four piers, with three entrances, forming detached breakwaters, the result of which would have been exceedingly ruinous, affording little or no refuge from a perpetual commotion and current arising from such an arrangement. It also holds out not the slightest remedy of getting quit of the annoyance of the shingle at the present harbour's mouth. Another plan, emanating from an eminent professional, introduced an idea of an under-water culvert; but has subsequently been abandoned in favour of Mr. Steward's plan. I trust I may not be considered presuming too much in venturing an opinion of the dangerous results likely to have accrued from the under-water threshold or culvert above alluded to, and proposed to pass through and under the new pier immediately in front of the present harbour's entrance, no doubt, with a view that the current of the tide, and an excessive action of the sea by passing through it, would convey the shingle past the present harbour's mouth; which only amounts, in my opinion, to a perfect delusion. That it would be passed thus by such means the length of the culvert, is a matter of extreme doubt; and it is obvious that an expansion of the current would take place at the egress of the flow, and, consequently, a diminution of its power. The result would be, an accumulation deposited immediately in front of the present harbour's mouth, and at a distance too great for the existing culverts in the present harbour to have any effect. Before passing from this subject, I have only further to state that, having considered it well, I do not see any better mode of combating the shingle successfully, than by detaining it in the bay to the westward of the harbour.

"In point of construction, Mr. Steward proposes the width of his piers to be 32 feet at top, having outwards an inclination of 75 degrees, and to be nearly 1¾ miles in length, with extensive wharfs, and terminating with light and signal houses. Batteries at the mouth of the harbour are judiciously omitted, Dover possessing many effective ones of low profile for defensive purposes. The erection of piers of such magnitude one would suppose could only have been approached by the most eminent professional engineers; but the various constituents and means recommended to be employed by Mr. Steward, although an amateur in the science, are, in my opinion, unparalleled for strength, durability, facility of construction, and cheapness of cost. I submit also that his mode of construction has been hitherto too little known. An inspection at the transverse section of the work presents an imperishable structure.

A REPORT BY MR. JOHN ROE, A.I.C.E.,

ON THE BROOKCOURSES AND GENERAL DRAINAGE OF THE TOWN OF DERBY.

To the Commissioners acting under the Derby Improvement Act.

Gentlemen,

In accordance with your request that I should report upon the best means of effecting the general Drainage of the Town of Derby, I proceeded to examine the locality, and to take measurements and levels, and to obtain such information as would enable me to fulfil your desire; and having examined the several plans you placed in my hands, of suggested remedies for the floods to which Derby is so often subject, I beg respectfully to lay the result of my observations before you.

The plan of Mr. Ross, is to arch over the Brook-course from the circular weir to the turn above the Morledge-bridge, and thence d-verting the line to pass in a more direct course to the tail of Messrs. Evans's mill—giving a superficial area of 200 feet to the upper part of the proposed arching, and increasing that area lower down as the junction of collateral streams render it necessary.

He also proposes a branch culvert 3 feet 6 inches high by 2 feet 6 inches wide. to collect the sewerage at the bottom of Dayson-lane, and to carry it along Curzon-street into the main line at Cheapside.

His plan also embraces flood-gates at the circular weir, and also at the Morledge-bridge, to secure the Brookwater for the use of the mills; self-acting flaps are also proposed, to prevent offensive effluvia arising from the covered sewers.

Mr. Frost's plan proceeds upon the desire to avoid part of the expense of Mr. Ross's plan, following nearly the same line, but giving a less fall to the course by deepening it from Messrs. Evans's mill tail, having a width of 18 feet and a height of 12 feet, providing an area of 216 feet for the passage of the waters. His Report also embraces the purchasing the right of Messrs. Evans to the water from the brook.

He also names the purchasing 30 horse water power for the use of water-works for Derby.

Mr. Harrison proposes to form a culvert eight feet wide, and 9 feet in height from the tail of Messrs. Evans's mill, along Thorntree-lane, Wardwick, and Cheapside, to Sadler-gate bridge; and passing under the bridge he proposes a culvert seven feet by seven, along Bold lane, Jury and other streets, to join the Brookcourse near the circular weir. He also provides for the brooks at Dayson-lane, in a similar manner to Mr. Ross. Sewers on the south side of the Brookcourse also form part of his plan. By these several sewers, the foul drainage of those parts of the town is proposed to be kept from that part of the Markeaton-brook, and the Brookcourse left open as at present.

Each plan has its respective merits, but neither of them meets the whole case to the extent which the instructions to myself require. In detailing the plan I hereafter respectfully suggest, the Commissioners will perceive how far I have used any of the preceding plans.

The whole of these plans fail in fully providing for the free passage of the flood-waters; for if the areas proposed are sufficient to convey all the waters of the floods, yet the outlet at the aqueduct, under the canal, (immediately below the tail of Messrs. Evans's mill) through which the waters pass, has only an area of 121 feet. So that if 230 feet is required above that point, the outlet having little more than half that area, must ever offer a serious obstruction to the free passage of the floods; and the water being brought by the proposed new lines to the outlet with increased velocity, would much increase the height of the floods in the lower part of the town, although their height in the upper part thereof would be diminished. It will be absolutely necessary, therefore, to commence operations at a point where this obstruction may be obviated.

Looking at the many obstructions that have been suffered formerly to accumulate along the Mark-eaton Brookcourse, the frequent occurrence of floods is not surprising. Some of the mill weirs have no flood-gates; some of the bridges are placed so as to present consider-

able obstruction to the direct passage of the water; the Kensington and Bramble Brooks, after their junction, enter the Markeaton Brook at right angles; the water from the Branch, through the Gas Works, enters the Brook in a manner to cause much impediment to the main current; and the connection of the collateral sewers are equally objectionable. In many places heads of piles stand up, and materially increase the friction, and consequently retard the current of water, and no attention has been paid to the curvature of turns in the Brookcourse. Beneath Sadler-gate bridge, a gas-pipe crosses, which in a flood must occasion a serious obstruction to the passage of the waters. The mere removal of these obstructions would have materially reduced the height of the late flood.

In the course of inquiry and examination, I find that from the conformation of the ground which drains into the Kensington, Bramble, and Markeaton Brooks, the floods are rapid in their rise, and do not remain long at their greatest height. This is a fortunate circumstance, as the high waters in the Brooks generally pass away before the flood comes to its greatest height in the river Derwent, into which, after receiving the other Brooks, the Markeaton Brook flows.

In considering a remedy for relieving the town from the effect of floods from the Brook, it is necessary in order to an efficient and economical laying out of the sewerage, to take it in connection with the general drainage of the town, and of this part in particular, in order to secure the profitable application of the manure arising therefrom.

As I shall have to repeat the suggestion I made to the Commissioners, as regarded Sections and Plans being provided for the consideration of the general drainage, I shall first consider the removal of the evil of floods, connecting it so far with the general drainage as appears necessary.

I have shown that the present aqueduct under the canal is insufficient for passing the flood waters freely; and as it is peculiarly situated, as regards the bridge and the sudden bend in the stream, it cannot judiciously be lengthened; neither can it be raised, unless another lock was constructed on the canal, as the iron plates and the planks which form the bottom of the canal, constitute the covering of the aqueduct. It remains, therefore, to construct an additional outlet under the canal, south of the buildings at the adjoining wharf, at the point marked with the letter A on the plan accompanying this Report. The direction thus given to the waters would be much better than that which the present course affords.

If the consideration of removing the evil of the floods was all that was required in looking at this question, I should say the line pointed out by Mr. Ross, or Mr. Frost, would offer the required facilities; but there are other considerations which must be taken in connexion therewith, as I before stated.

The area necessary, however, to pass the water, requires mature consideration, from actual data, as yet in a great measure to be obtained—for the late high flood occurred after Mr. Ross had formed his calculations, and this flood appears to have exceeded in height any former flood; and although Mr. Frost has given an additional area of sixteen feet above Mr. Ross, yet by lowering the bed of the brook, as he proposes, below the line of Mr. Ross's section, the fall is decreased, and consequently the velocity of the current of water would be decreased, so that the additional area would not compensate for the loss of speed.

From levels I have taken to the different flood marks, I find the area occupied in two places to have been 320 feet in one, and 337 feet in the other. If the velocity of the current of water had been ascertained, there would be no difficulty in fixing the size of the arch required, to convey the whole away. Mr. Spencer collected from the opinion of several individuals, that they considered the velocity to be from nine to ten miles per hour; whilst others, of whom I inquired, gave their opinion as at five miles per hour, and some less than that. I found no rain-gauge to which I could refer, for the actual depth of rain that fell at that period, or an approximation might have been arrived at, as the surface draining into the Markeaton and the other brooks, is about 13,000 acres, of which about 500 acres is occupied by roads, streets, and buildings. My own opinion is, that if the velocity of the current had been taken, it would not have been found to average more than about 3½ miles per hour through the town.

Seeing therefore the discrepancy on this material point, I do not feel justified in at once recommending the arching over the Brookcourse, although ultimately it will be found necessary to do so.

I now proceed to describe the plan I consider it would be advisable to adopt, under all the circumstances; which, if carried out, would at once relieve the town from the evils accompanying the floods, and enable an accurate average of the velocity of the current to be taken, so that the size of the arch for covering the Brookcourse may be safely fixed; a course which will prevent an inefficient work on the one hand, and avoid any excess of expenditure on the other.

In looking at the question of complete drainage for Derby, and the profitable application of the refuse, it becomes necessary to divide the foul drainage from the Brookcourse, there being a great quantity of water passing continually along the brook, which need not all be mixed with the sewerage; the doing so would only increase the expense of conveyance for irrigation, or into tanks for subsidence. Such being the case, the main sewers may be formed in such lines, and of such capacity, as to enable them to be used in carrying off a very considerable portion of the flood waters; and this will not increase the ultimate expense of arching to receive all the flood-waters, but will render the taking down buildings for hereafter arching the Brookcourse unnecessary.

I have named the necessity of forming an additional outlet under the canal, at the point marked with the letter A on the plan, as a matter indispensable, whatever plan be adopted above that point.

I would recommend that a sewer of nine feet high and ten feet wide in the clear, be constructed from the point marked with the letter B on the plan, along Thorntree-lane, Victoria-street, and Wardwick, to the point marked with the letter C on the plan—thence along Friar-gate, George-street, Cavendish-street, and Ford-street, to the point marked with the letter D on the plan, of the height of 8½ feet, and width of 8 feet in the clear, with proper flushing apparatus to keep it clear from accumulation of foul deposit.

The section of this line is marked with the letter W. At D proper flood gates to be fixed, to be drawn during floods, and for the purpose of flushing. A sewer 4½ feet high and 2¾ feet wide, along Agard-street, from the point I, to and along Mill-street, to the point marked with the letter H on the plan.

Another line of sewer from Cheapside, at C on the plan, 5 feet high and 4 feet wide, to and along Bold-lane, Jury-srseet, and Willow-row, to F on the plan, thence a sewer 5 feet high, and 3½ feet wide, along Ford street, Brook-street, and Nuns'-street, to the point marked G on the plan.

Along Curzon-street, from the point E to K a sewer 6 feet high and 4 feet wide, to convey the foul drainage from the brooks, meeting at the lower end of Dayson lane; this would take much of the flood-water, and the course through Mr. Jessopp's land may be covered over, when the particulars hereafter named may have been obtained.

Any existing drainage would be connected in a proper manner with the new lines.

The present Brookcourse, from the Morledge-bridge to near Nun's mill, as shown on the Section, marked with the letter X, to have an invert of brickwork placed in it, and obstructions removed; flood-gates to be placed in the circular weir and opposite the two culverts at the Morledge-bridge, in lieu of the present masonry, to allow a free passage for the water in floods, or for flushing. A gate, also, near the Morledge-bridge, to keep back the flood or other water from the Derwent when required.

The existing drainage between the two main lines, collected at various points, and carried to the sewers.

The cost of these several works would amount to the sum of £13,564.

The execution of them would relieve the town from the evil arising from the floods, as the water, by the use of the flood-gates and new sewers, would pass through the town on a level several feet lower than formerly, and the advantage of the increased velocity that would be given to the current of water, by passing along smooth brick inverts, instead of encountering the present innumerable obstructions, would be greater than can justly be appreciated by any person who has not practically had opportunity of noting the difference. By occasional flushing, the accumulation of deposit would be prevented, so that the cause of offensive effluvia would, in a great degree, be removed.

I would here remark, that something should be done as early as possible, to relieve the town from the danger of floods, for since the last great flood, erections have taken place which will tend to increase the height of any considerable flood materially.

I have not named the enlarging the line below the Morledge-bridge

to the tail of the mill, as the size will depend on the particulars next noticed.

In order to ascertain hereafter what size the arch in the brookcourse should be, the following particulars should be obtained after the above works have been completed. On the occurrence of a flood, the area occupied by the water between Mr. Duncan's factory and the mill opposite, should be measured, and the velocity of the current of the water taken and noted down; also the height the water attains in several parts of the brookcourse, and its velocity ascertained, knowing the height the water attained in the great flood of 1842, and the area it occupied at the above named point, with particulars here stated, the size required for arching over the brookcourse can be accurately defined, as well as the size required from the Morledge-bridge to the outlet. In arching over the brookcourse, and completing the line, Mr. Frost's plan of cross-arching from iron beams may be found very applicable. The cost, I believe, will not exceed £6,030, and the value of the covered site of the brookcourse is estimated at £2,680.

The area occupied by water that may at the same time of flood pass along Mr. Jessopp's grounds, should be measured, and the velocity noticed, in order to ascertain what sized sewer may be requisite for covering that course in; a work which it will ultimately be necessary to complete, as forming a part of the general drainage of the town; the cost, however, will be found to be trifling.

In speaking of the above-named works, I have not noticed two things which I would, however, recommend the Commissioners to effect, if possible; namely, the purchase of the water-right of St. Mary's mill, and the right to the Brookwater from Messrs. Evans.

The first I would recommend on the ground of public health, as the large mill-dam connected therewith is a source of malaria, particularly during the summer months, when animal and vegetable matter lies decomposing on the portions that are occasionally bare of water.

If this right was purchased, the flood-gates at D and the circular weir might be dispensed with.

The purchasing the right of Messrs. Evans to the water from the brook, would render the use of flood and other gates at the Morledge-bridge unnecessary; and whenever the Commissioners may decide to commence operations for the profitable application of the sewer refuse, the common run of water in the brook might be conveyed to near the outlet at small expense, and in such manner as to derive its full power to be used in raising the foul sewerage to a level, whence it could be conveyed in pipes to the different meadows for irrigation; and when not required for this work, it would pass to the mill-tail by the main line. As some power would be required to raise the foul sewerage for irrigation, and Mr. Frost, who is a very competent judge, considers Messrs. Evans' right to the brookwater as worth about £500. This would be the cheapest mode of obtaining lifting power: and Anthony Rudford Strutt, Esq., in his letter to Mr. Frost, strongly recommends the purchase of this water-right. The flood-waters can be passed off without such purchase taking place; but on the grounds of public health and utility, I would call the attention of the Commissioners to the subject.

The profitable application of the filth from the sewers, is a point which has not received the general consideration due to it; for until Mr. Chadwick, in his "Report to the Poor Law Commissioners, on the sanitary condition of the population of Great Britain," drew public attention to the subject, little had been said or thought of it. In the case of Edinburgh (vide Report p. 49), the increase of the value of poor lands thus irrigated, is shown to have been from 30s. to £15, and in some cases to £20 per acre; other lands, once let for 40s. to 50s. per acre, now let for very high sums. It is true that the inhabitants around those meadows object to it as offensive; the value however of the irrigation is seen by the parties interested in about 300 acres of land, estimating the compensation that would induce them to discontinue the practice at £150,000.

In the case of Derby, the refuse may be conveyed by pipes to the meadows below the town, where no such objection could arise; and the residue not used in irrigation would pass without raising into tanks situate at a distance on the banks of the canal, which offers a ready and cheap means for conveying the solid portions to distant places for manure.

Captain Vetch, an experienced engineer, states, in his report on the drainage of Leeds, "that from the researches in agricultural chemistry, and from the usages of other countries, the value of the manure for each person in a town, may be safely estimated at 10s. per annum." The population of Derby is about thirty-five thousand; of this population about two-thirds could drain to the proposed sewers; the value of the manure to be conveyed to the sewers, if proper water-closets were adopted, would therefore be about £11,000 per annum. It is not, however, to be expected, that the manure would be immediately applied, so as to produce its full value: still, if it be admitted that in a few years it would reach one-fifth of its value, or £2,200 a year, (and this it might by irrigation alone), it would be bad policy to allow so much fertilizing matter to be sent to the river, where it is lost to every good purpose as regards the town of Derby.

At those periods when irrigation was suspended, the foul water would pass into tanks formed to receive it, where the more solid portions would precipitate, and afterwards be taken out and boated away for use as manure.

Mr. Smith, of Deanston, and other authorities on drainage and irrigation, consider the application of sewer refuse by irrigation, as the most productive mode of distributing the manure.

The contractor for the soil from privies and cesspools in Paris, pays to the municipality the sum of £22,000 for the right to use it for the present year.

The cost of mill house and machinery to raise the sewer-water for irrigation, with iron pipes to convey it to half a mile below the town, with a sewer and tanks for receiving it when not using in irrigation, with compensation for land, &c., would not exceed £4,500, including the sewer to convey the brookwater to the wheel, if the right to it is purchased from Messrs. Evans.

Forming the meadows for irrigation, would cost about £5 or £6 per acre.

The annual cost of attendance to the sewer-water would be trifling.

I would now say a few words on the general drainage of the town.

The river Derwent passing through the town, divides it into two unequal portions, which will have to be discussed separately as to drainage and sewerage.

On the west bank of the river, the undulations in the surface are favourable for a good drainage, and it is desirable that a town, which may rank with any in its general clean appearance, should possess a complete system of sewerage, the want of which in any place being productive of disease, and consequent misery and loss to the community at large.

The drainage at present is very inefficient, both as to size and level, except in some instances where a judicious foresight has avoided those evils. In some cases the water from cellars has to be lifted up, at considerable loss of time, and with much inconvenience, into a trough, to attain the level of the drain in the street; whereas, if the street drain had been kept to the level which the outlet affords, and of a proper size, it would have served efficiently at a level much below the bottom of the cellars.

The numerous courts also require a proper drainage, and such a supply of water as would enable the soil from the privies to be passed to proper sewers, instead of being connected with the dust-holes as at present.

A measure should be adopted by which the evils entailed by inefficient drainage may be remedied, and a stop put to any further increase of those evils; and this should be done promptly, for the longer the present insufficient system is continued, the greater expense will it entail upon the town, and the time will arrive when the matter can no longer be passed over.

The first thing that should be done, is to give your surveyor directions to take the levels of every street and court in the town, and to form the necessary sections, a duty for which he is fully competent; ascertaining the extent and character of the existing sewerage and drainage—noting what streets are supplied with water laid on to the houses—what streets or courts only with common cocks or pumps, what have conveniencies for discharging refuse by apparatus of water-closets—what streets or places have only cesspools to the houses—what have only receptacles common to many dwellings, and what streets are undrained.

The levels should all have a reference to a fixed datum or bench mark, (say at one yard below the iron cover of the aqueduct under the canal near Messrs. Evans's Mill.)

The next step should be the making of a Plan of the town to a con-

venient scale. There are good surveys of the town taken some years since, and these would afford material aid for such purpose: the streets and courts built since those surveys were made should be added.

It cannot be expected that your surveyor could do all this without assistance, but assistance should be allowed him, which individuals in the town no doubt are able to afford, and this would be the least expensive method of accomplishing an object which is necessary to be obtained.

When these materials are provided, I shall be happy to render my assistance in pointing out the best method of adapting the existing sewerage, and such lines of new sewers as may be required to form a complete system of drainage for the town; one which would combine the advantages of the avoidance of all accumulations of filth in the sewers, and the consequent offensive effluvia arising therefrom, and also save the breaking up the streets to clean out the same; matters which, as they affect the health, comfort, and cleanliness of the inhabitants, are of great importance; and which also possess the advantage of pecuniary saving.

The plan laid out should be enforced on all future occasions of building sewers, a course which would be beneficial to the builders and to the community at large.

The many improvements that have taken place at Derby, give the town an air of cleanliness and comfort which stands second to no other place; a town so pleasantly situated, ought no longer to be subject to calamities so easily removed, the removal of which is the only thing required to make it one of the most desirable places of residence in the kingdom.

If the Commissioners have not sufficient powers under their act to enable them to correct the evil, and to prevent it in future, they ought to possess those powers without delay, in order to secure the health and well-being of the town; and at no more favourable opportunity than the present could they apply to the constituted authorities for proper powers, who exhibit their sense of the importance of such a subject by having appointed a commission composed of some of the most active, able, and talented men that could have been selected, to inquire into every matter connected with the health of the town.

I need say but few words on the subject of raising money to defray the cost of these works. Mr. Chadwick, in the report before-named, suggests that the amount required should be borrowed on security of the rates, and repaid by instalments with interest in a period of thirty years. The sum needed for the suggested works at Derby may be borrowed, and the interest paid by a rate, until the value of the manure came to redeem the capital expended.

In conclusion, I beg to acknowledge the assistance I received during my inquiry, from many of the Commissioners and from their clerk, as also from the Surveyor, whose unceasing attention and assiduity evinced the great desire he felt to carry out your instructions to the fullest extent.

I am, Gentlemen,
Your obedient and faithful servant,
JOHN ROE.

July 27th, 1843. Sewers Office, Hatton-Garden, London.

BAR HARBOURS.

It is impossible to calculate the amount of money that has been expended in an attempt to remove the bars with which nearly all the harbours of this country are more or less encumbered. Hitherto, however, no really permanent advantage has been obtained. Some of the harbours which would have been silted up by the accumulation of detritus have been kept open by a proper direction of back-water; and the entrance of others has been partially maintained over shingle beds by sluicing, but in every instance the effort of the engineer has been to cure an evil rather than to prevent its existence. Considering the works which have been undertaken, and the object, either expressed or involved, proposed by those who have contrived and directed them, one might almost imagine that their engineers have been unconscious that the physical conditions which, from an interference with the utility of their works were considered evils, and which they were required to cure, arose from the natural action of fixed laws imposed upon the states of matter. The engineers of past times, as well as those of the present age, at least in this country, have failed to study the origin of the phenomena they ought to have removed, and have been quite incapable of devising new conditions to produce the results they wished. They have attacked the effect instead of removing the cause, and however successful they may have been in this, they have done little real service to the navigation of our coasts, for their works have been most ineffectual where most required. In selecting an example of this, the mind naturally turns to that most notorious of all instances, Dover harbour. Thousands of pounds have been expended there in an attempt to remove an effect without the slightest reference to the cause. In stormy weather, when it is most necessary to keep the mouth of the harbour open, the sluices are of least value; and in periods of quietude, when the incumbrance is of small comparative importance, they inadequately remove what natural agencies would in a rather longer period do much better. The same remark applies with greater or less force to every harbour on the south-eastern coast of England, so that it may be safely asserted that there is no harbour which can be at all times entered by the class of vessels for the shelter of which they are chiefly intended. We need not, therefore, hesitate to assert, that those who have been employed to improve our harbours, have been culpably ignorant of the principles which should have guided their decisions, for we are unwilling to attribute to them a neglect of duty, which is the only other cause that could have occasioned the failure of their plans.

But it is not by mourning over the ignorance of our predecessors that we can obtain the knowledge by which alone we shall be able to excel them. The subject has not yet gained the attention of the profession, but the efforts now making to induce inquiry, and to elicit a statement of opinion, will not be without their beneficial effect upon future investigation. It is, however, useless to urge examination and thought upon this momentous question without giving the inquirer some information, or at least some hints to direct his investigations. This object the writer has at present in view.

In the examination of a bar-harbour, the first thing to be ascertained, is the substance or matter of which the bar is formed, for it is only by its characters that the engineer can be guided in his attempt to trace it to its origin. Sometimes it is formed of a siliceous sand, at others of argillaceous matter, and in some instances of beach or shingle. But all bars, considered in reference to their composition, may be divided into two classes, sedimentary and erratic. The want of a proper distinction between these two kinds of bars has been the cause of great confusion in the minds of those who have written in English on the subject, and has originated the promulgation of opinions which, though in reference to one class have been near the truth, have been in regard to the other equally erroneous. Mr. Brooks, a modern writer on this subject, has for want of this distinction exposed himself and his theory to many objections. No one at all acquainted with the subject will assert that all bars are formed from the same cause, or that any one condition will in every instance effect their removal. They are formed in different ways, and the works intended for their removal must be designed in reference to their mode of formation.

If it be ascertained on examination, that the bar of a river consists of a mineral mass, produced by sediment, it will not be difficult to discover whether the accumulation is produced by the action of tides or currents, or whether it is brought down the channel of the river by its waters; or, in other words, whether it owes its origin to a deposition from the waters of the ocean, or whether it is the result of the disintegration of the banks of the river by the abrading influence of the

channel waters. The estuary of Kingsbridge, on the south coast of Devon, offers a very striking and remarkable example. The channel is cut through a clay slate, excepting at the mouth, which is formed between two lofty eminences of mica slate, well known as the Bolt Head and Tail. Into the valley of the estuary of Kingsbridge numerous other valleys discharge their surface waters, all being denudations in the clay slate rocks. The consequence has been, a rapidly increasing deposit of argillaceous matter, which, a few years ago, had rendered the stream almost unnavigable for small vessels of burden. But in the mouth of the estuary a bank or bar of fine silicious sand has been accumulated, of the same character as that which is found so abundantly on the Slapton sands, and in the numerous caves of the lofty shores in the same neighbourhood, consisting of mica and chlorate slates, quartz, and other rocks of the same group. From these facts no one can doubt that, although the deposit in the upper portion of the river proceeds from the action of the water upon the banks of its channel, and the debris brought down by the natural drainage of the contiguous district, the matter of which the bar is formed is brought into its present situation by the sea. Now it must be evident, that in any attempt to remove this sand bank it will be necessary to adopt a very different mode of proceeding than if it were formed by an accumulation of the debris formed or collected by the river.

The formation of a bar to a river by the stoppage of the detritus brought down from the country through which it flows, may arise from a variety of circumstances. It may be a too great capacity of the channel for the body of water to be discharged, it may be the sluggishness of the stream, or the inclination of the bed, or the angle at which the waters are discharged into the sea. These and many other partial causes have been pressed into the service of certain theorists, who have been anxious to attribute to one or the other every instance of the formation of a bar. But there is no one condition to which all accumulations can be referred. That which, applied in one instance, may give a good reason for a particular state, will be found in another quite inapplicable. The same disease may be developed in different constitutions, not only from different but almost from opposite causes; and so in the natural operations of physical agents, the modifying influence of secondary conditions is varied to so great an extent, that almost opposite results may be produced under the apparent guidance of the same motive power.

But whatever difficulty may attend the formation of an opinion as to the immediate and influencing causes in the formation of a sedimentary bar, the perplexity increases when the attention is turned to the phenomena which attend the erratic or shingle bars, so peculiarly distinguishing the harbours of the south-eastern coast. Neither the term shingle nor erratic fully conveys the idea the writer would communicate to the reader—but on another occasion it may be desirable to discuss the necessity of a more precise nomenclature in the future investigation of this most important branch of scientific inquiry. The erratic bars are those formed of drifted material, commonly of beach or shingle. The best writers upon this subject have considered the shingle bars to be a class by themselves, but as bars of erratic formation are sometimes formed of silicious sand, and of mineral matter in other states, the opinion conveys an imperfect if not an erroneous idea. It is for this reason that the term erratic may be preferred as a generic expression, the shingle bars being but a class, and the phenomena peculiar to their accumulation or motion may be attributed to the rolled masses of which they consist.

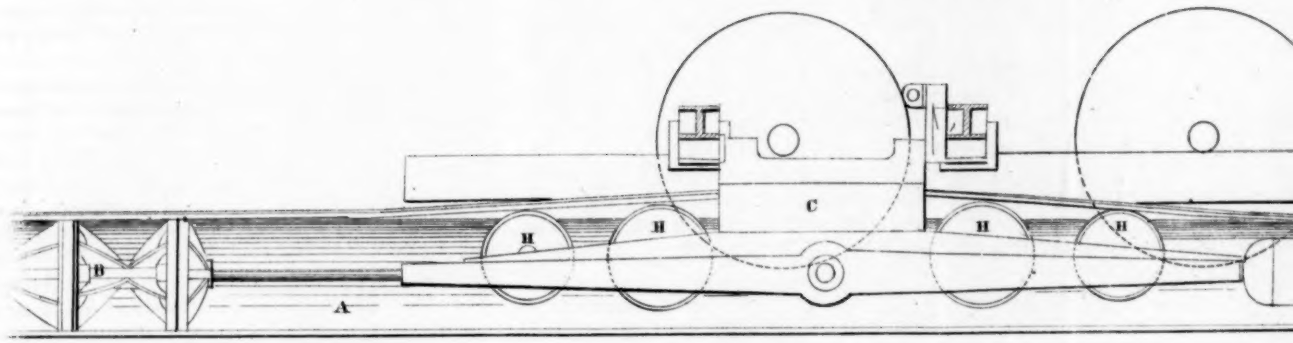
But without reference to the nature of the bar, which simply constitutes the varieties of a class, they are distinguished from all others in their accumulation and formation from being composed of a detritus brought to shore by the sea into which the river or harbour discharges itself, and not from the effluent waters. No one supposes for a moment that the discharge of water from the encumbered mouth of a river or harbour has had no influence in the production of the bar, but to ascertain the cause of the accumulation, we must first discover the state of the accumulated matter before it is brought within the range of the influence of effluent water. That state is one of continued motion. The shingle upon the coast travels with the winds, having one line of accumulation, and others of dispersion. To ascertain the lines in which it travels should therefore be the first inquiry of an engineer, in his attempt to prevent its accumulation in situations where it interferes with navigation. Mr. Prichard, in his Report upon Shoreham Harbour, has commenced his investigations aright in directing his observations to the travelling of the shingle, and the causes which tend to destroy the accumulations. When once this subject is fully understood, there may be some hope of ascertaining the influence of coasts, the mouths of harbours, the flowing of streams at an angle to the motion of tide or current, and other conditions in retarding the progress of the travelling detritus, and producing bars of erratic matter.

THE PRINCIPLE AND CONSTRUCTION OF THE ATMOSPHERIC RAILWAY.

The *principle* of the Atmospheric Railway, to the results of which we drew the attention of our readers in the last number of our Journal, is by no means new: it has been known to scientific men for many years. The first proposal for applying the pressure of the atmosphere for the purpose of transit, was made to Mr. Clegg, and Mr. Duckworth, of Manchester, by a Mr. Taylor, in the year 1805. Mr. Taylor first proposed that an air-tight tube or main should be laid down between London and Windsor, and that it should be fitted with a piston having a chamber attached, to contain dispatches, which piston should be set in motion by pumping the air in advance of it out of the main, and thus transmitting its contents from London to Windsor, in a very short space of time. Mr. Taylor also proposed to lay down a similar main between London and Edinborough, but the scheme was treated with coolness, if not with disdain, by some, as the chimerical proposition of insanity. Plans of a similar nature, differing only in construction, were laid before government from time to time, but met with no more encouragement. In 1827, Mr. George Medhurst, civil engineer, of Denmark Street, Soho, published a pamphlet, entitled, "A new System of Inland Conveyance for Goods and Passengers, capable of being applied and extended throughout the Country, and of conveying all kinds of Goods, Cattle, and Passengers, with the velocity of sixty miles in an hour, at the expense that will not exceed the one-fourth part of the present mode of travelling, without the aid of horses, or any animal power." Mr. Medhurst says,—"In order to apply this principle to the purpose of conveying goods and passengers from place to place, a hollow tube or archway must be constructed the whole distance, of iron, brick, timber, or any material that will confine the air, and of such dimensions as to admit a four-wheeled carriage to run through it, capable of carrying passengers, and of strength and capacity for large and heavy goods. The tube or aërial canal must be made air tight, and of the same form and dimensions throughout, having a pair of cast-iron or stone wheel tracks securely laid all along the bottom for the wheels of the carriage to run upon; and the carriage must be nearly of the size and form of the canal, so as to prevent any considerable quantity of air from passing by it.

"If the air is forced into the mouth of the canal, behind the carriage,

THE ATMOS



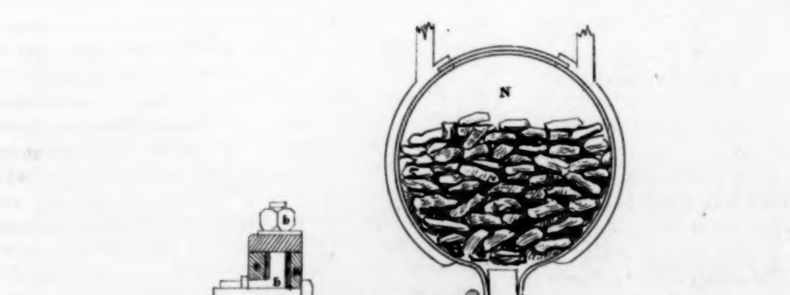


Fig.3.

Fig. 4.

OSPHERIC RAILWAY.

Fig. 1.

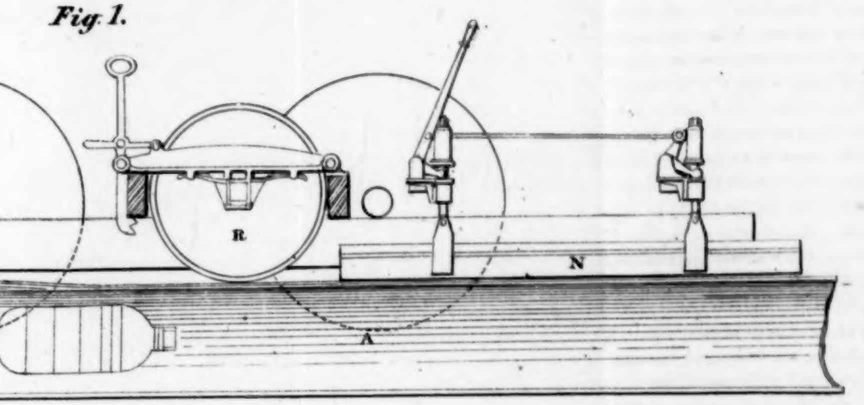
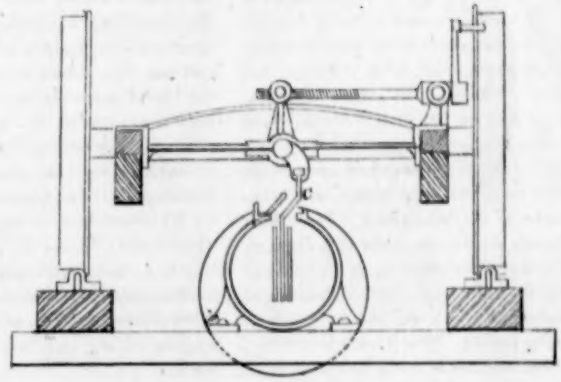
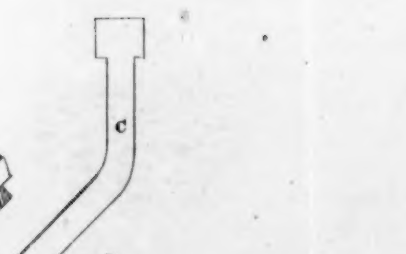


Fig. 2.





4.

Fig. 5.

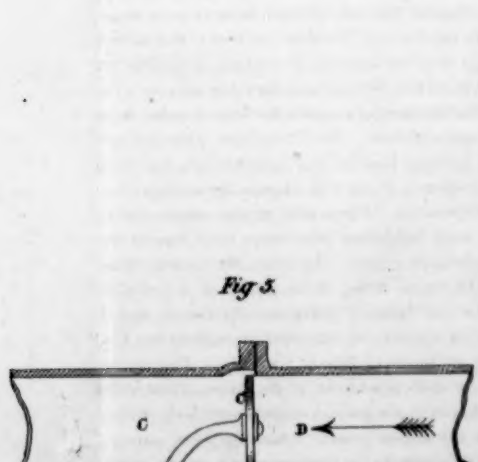


Fig. 6.

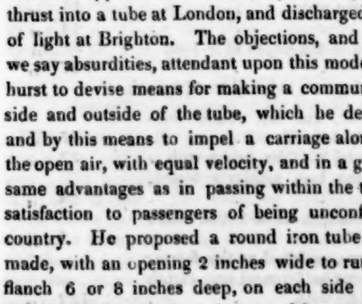
Lith. by Nasworthy & Wells 24 Union St Moorfields

by an engine of sufficient power, it will be driven forward by the pressure of the air against it; and if the air is continually driven in, the pressure against the carriage, and consequently its motion, will be continually maintained."

The proposed dimensions of this canal, to answer the purpose of internal conveyance effectually, was 6 feet high, and 5 feet wide. It was stated, that there would be no necessity for the carriage to fit the canal very precisely, so as to be worn away by the friction against it, or to increase the resistance of the carriage; for if there was one inch of open space all round, between the carriage and the sides of the canal, the quantity of air that would escape through that opening would not exceed the 25th part of the whole that is forced in, and which might be effectually compensated by increasing the power of the engine in the same proportion. It was further stated, that the power necessary to convey 5 tons of goods through a canal of 30 feet in area, at the rate of one mile in a minute, must be equal to the raising of a weight of 1,055 lbs. 88 feet high per second, equal to the force of 92,840 lbs. moving one foot per second, equal to the labor of 185 horses, and would be produced by the consumption of 6 cwt. of coals per hour, and in this time, 5 tons of goods would be conveyed 60 miles, which is not one halfpenny per ton per mile. The total expense of construction, Mr. Medhurst stated to be £10,000 per mile, which included the value of the land, and every contingent apparatus.

When the carriage was to go through the canal *from* the engine, the air was to have been forced into the canal behind it; but when it was to go the contrary way, the same engine was to draw the air out of the canal, and rarify the air before the carriage, that the atmospheric air might press into the canal behind the carriage, and drive it the contrary way.

This proposed system was the same as that of Mr. Taylor, but more extended; many of our readers will doubtless remember the caricatures that appeared at the time, representing travellers unceremoniously thrust into a tube at London, and discharged through it with the speed of light at Brighton. The objections, and we may be pardoned if we say absurdities, attendant upon this mode of transit, led Mr. Medhurst to devise means for making a communication between the inside and outside of the tube, which he declared to be practicable, and by this means to impel a carriage along upon an iron road, in the open air, with equal velocity, and in a great degree possessing the same advantages as in passing within the tube, with the additional satisfaction to passengers of being unconfined, and in view of the country. He proposed a round iron tube 24 inches diameter to be made, with an opening 2 inches wide to run the entire length, and a flanch 6 or 8 inches deep, on each side of the opening. If the flanches of this tube were immersed in water up to the circumference, (as shown in the figure) a communication would at once be formed between the piston travelling inside and the carriages outside.



The 6 inches head of water by which this tube is sealed, would bear a pressure of 4 oz. per inch. And although Mr. Medhurst makes out that 12 persons could by this force be conveyed at the rate of 20 miles per hour, it would in reality do little more than overcome the friction of the piston travelling inside the tube. The channel of water must of course have been level, and he intended to overcome inclines by a series of steps, the carriages, by their own momentum, taking them up the steep short incline between the two.

Once more, after this contrivance, Mr. Medhurst altered his plan for a valve, and came quite as near to perfection as either Mr. Vallance or Mr. Pinkus did after him.

He says, in order to make the continuous valve in the best manner, the top of the pipe should have a long opening, furnished with a hinged plate of wrought-iron, or copper, on one edge, and on the other must be rivetted some soft substance, such as cork, or leather, which would fall against a corresponding piece of the like substance, secured to the pipe, and an air-tight joint thus formed; the opening of the valve should be in the middle of the top, so that an iron arm might pass out, and stand upright a few inches above the top, to which the strap should be attached, to communicate motion to the carriage.

In this state was the contrivance for applying atmospheric pressure to the purposes of locomotion, when Mr. Pinkus took it up, and in this state he allowed it to remain.

It is for an air-tight valve we are indebted to Mr. Samuel Clegg, and his patent simply claims the invention of the means to make it tight.

We now give the drawings and description of Mr. Clegg's apparatus, by which a practicable, safe, and economical means of transit is at length secured.

The moving power is communicated to the train by means of a continuous pipe A, Fig. 1, laid between the rails, and divided by separating valves, figs. 5 and 6 (to be afterwards described,) into suitable and convenient lengths for exhaustion, so that the lengths between any two valves may be said to represent one short railway complete in itself, which may be multiplied any number of times, and form a length of line as great as required. A partial vacuum is formed in each section of the pipe A, either by steam-engines or water-wheels working air pumps. These separating valves are opened by the train as it advances, without stoppage or reduction of speed (unless required at a station). The piston, B, which is made to fit air tight, by a leather ring pressing lightly against the sides, is introduced into the main pipe, and connected to the leading carriage of the train by an iron plate, C, fig. 1, which travels through a lateral opening the entire length of the pipe. This lateral opening is covered by a valve, G, formed of a strip of leather riveted between iron plates; the top plates are wider than the groove, and serve to prevent the external air forcing the leather into the pipe when the vacuum is formed; the lower plates fit the groove when the valve is shut, and making up the circle of the pipe, prevent the air passing the piston, as shown in figs. 3 and 4, which are transverse sections of the valve, drawn to a 3-inch scale; one edge of this leather valve is securely held down by a wrought-iron bar, *a a*, fastened by screw bolts *b b*, to a longitudinal rib, c, cast in the main pipe; the leather being flexible, forms a hinge, and allows the valve to open *from* the bar *a a*, like a common clock valve; the other edge of the valve falls on the opposite lip of the groove, and forms a trough F, which is filled with composition of bee's-wax and tallow, a substance solid at all temperatures of the atmosphere, but becomes fluid when heated a few degrees above it; the adherence of this composition to the leather and the cast-iron, produces perfect contact between them, and makes an air-tight joint. As the piston advances, the valve, G, must be raised into the position shown at fig. 4, to allow the connecting plate, C, to pass, and this is effected by four wheels, H H H H, fixed to a frame on the piston-rod, and the aperture

thus formed serves also for the free admission of air to press on the back of the piston; by this operation of raising the valve out of the trough, F, the composition is broken, and the air-tight contact is reproduced by the wheel, H, attached to the carriage, which ensures the perfect closing of the valve by running over the top plates after the plate C has passed, and the heater, N, about 5 feet long, filled with burning charcoal, also fixed to the carriage, runs over the surfaces of the composition, and rejoins the composition by rendering it partially fluid, which, upon cooling, becomes solid, as before. Thus each train in passing leaves the pipe in a fit state to receive the next train.

The separating valves are shewn in figs. 5 and 6. The latter is the *exit* valve, or that at the end of the section nearest to its steam engine, opened by the compression of air caused by the friction after it has passed the branch which communicates with the air-pump.

Fig. 5 is the equilibrium or *entrance* separating valve. The pipe is exhausted on the side of the valve lettered C, and is only prolonged on the other side to allow the piston to enter the pipe before the valve is opened. The arrows denote the direction in which the train advances.

Attached to one side of the main is a semi-circular box, BA, divided into two compartments by a partition, *a a*, through which is a circular opening; on the top of the box are two square holes, one on each side of the partition, furnished with a box slide, by which either or both may be opened at pleasure; within the box, B A, are two valves, *b* and *c* (*b* having the greatest area), connected by an arm *d d* to each other, and to a vertical axis, *e*, on which they can swing horizontally.

When the pipe is to be exhausted, the valves are placed in the position represented in the figure, *b*, closing the opening in the partition, or closing the main; the box slide also covers the hole on the side B of the partition, leaving the other hole open as the exhaustion proceeds; C and B are in vacuo, A and D open to the air. There is then the same pressure on each square inch of *b* and C, but *b* being larger than C, both remain close. But the train, on approaching, moves the slide box so as to cover both holes, and a passage is formed through which the air in the portion A rushes into the main, so that A and B are both in vacuo, and the pressure being removed from *b*, that on C forces it back and allows the piston to pass.

The *working* of the trains, as far as traffic is concerned, is regulated precisely in the same manner as on common railways, but there is neither danger nor inconvenience, and the average speed is proposed to be 40 miles per hour.

Note.—Figs. 1, 2, 5, 6, are on a scale of half an inch, and figs. 3 and 4 on a scale of three inches to the foot.

EXPERIMENTS MADE UPON CAST AND MALLEABLE IRON.

By David Mushet, Assoc. Inst. C.E.

(Continued from page 277.)

In all these trials, excepting one, the hammer used was 24 lbs. in weight; and, in order that the physical force applied should suffer no abatement, there were relays of strikers, sometimes two and sometimes three, and no one was allowed in his turn to apply more than ten blows to the bar or bolt under experiment.

It may be observed here, that the whole of the bar iron subjected to trial, was manufactured from hot-blast pig iron, and either afterwards refined or puddled from the pig.

Four bars of flat-iron, 4 inches broad, and 1¼ inch thick, No. 3 quality, and puddled from refined metal or plate.

First bar, cut one-eighth of an inch deep on the upper surface, with fifty blows of the 24 lb. hammer, deflected from the straight line 5 inches; at 100 blows, 5¾ inches; with 150 turned a few degrees beyond a right angle, and doubled up flat at 163, exhibiting a mass of bright silvery fibre.

The second bar, treated in a similar manner, with 50 blows deflected 6 inches, at 90 turned to a right angle, and with 160 blows turned down flat, exhibiting in its fracture a similar quality of fibre.

Two pieces taken from the end of these bars, about one foot in length, and without notching, were placed under the breaker—one turned round, and shut up close, with a slight fissure in the bend; the other opened about three-eighths of an inch, discovering beneath strong silvery fibre.

The second bar, treated in a similar manner, with 50 blows deflected 6 inches, at 90 turned to a right angle, and with 160 blows turned down flat, exhibiting in its fracture a similar quality of fibre.

Two pieces taken from the end of these bars, about one foot in length, and without notching, were placed under the breaker—one turned round, and shut up close, with a slight fissure in the bend; the other opened about three-eights of an inch, discovering beneath strong silvery fibre.

The third flat bar, cut one-eighth deep on the upper surface. 6 inches from the end, broke with nineteen blows at one end, and with twenty at the other end; the fracture was bright, and was composed of about one-third fibre, and two-thirds small bright grain.

The fourth bar, treated in every respect the same, required forty-five blows on the one end, and fourteen on the other; the proportion of fibre and bright grain being nearly the same as in the last, or No. 3 bar.

Four bars of the same sized iron were puddled from pig iron, and were broken as follows:—

First bar, broken with . . .	14	blows
Second, ditto	38	„
Third, ditto	43	„
Fourth, ditto	21	„

The fracture of these bars showed less fibre, and more of bright grain, than the bars made from refined metal.

Four 2¾ inch bolts, made from refined metal, were tested as follows:

1st bolt, cut one-eighth deep, half round, 7 inches from its end (the notch in this, as in all the experiments, was placed perpendicular to the edge of the anvil), broke with . . .	29	blows
The other end with . . .	42	„
2nd bolt, notched in the same way . .	55	„
The other end	44	„
The same bolt cut all round to the depth of 3-16th	51	„
The other end	27	„

Diameter of fracture reduced to 2⅜th inch.

3rd bolt, 2¾ inches diameter, cut half round one-eighth of an inch deep, broke with . .	47	„
Cut all round to the depth of 3-16ths, broke with .	33	„
The other end of the same bar, similarly tested, broke with	94	„
When cut all round to the depth of 3-16ths, broke with	5	„
4th bolt, 2¾ inches diameter, puddled as the former three from plate metal, cut half round one-eighth of an inch in depth, broke with . .	122	„
Cut all round to 3-16ths deep . .	16	„
The other end of the bolt, cut half round, and notched one-eighth deep . . .	18	„
Cut all round 3-16ths . . .	7	„
One bolt, 2¼ inches diameter, puddled from refined metal, cut half round, and notched to the depth of one-eighth, required to break it . .	120	„
Notched all round one-eighth deep (at another part of the bar)	167	„
One 2⅛ bolt, cut half round . .	80	„
Notched all round one-eighth deep . .	31	„
Another 2⅛ bolt, cut half round . .	47	„
Notched all round . . .	17	„
A bolt, 1½-inch diameter, cut half round, required to bring it to a right-angle . . .	25	„
Twelve more to break it; in all . .	37	„
Notched all round, broke with . .	34	„
A 2¼-inch square bar, puddled from metal, notched 6 inches from the end upon its upper surface, one-eighth of an inch deep, broke with . .	54	„

The other end, ditto, over-heated . .	5	„
A second bar of the same size and quality, notched in a similar manner, was broken with .	84	„
The other end, treated in the same way .	36	„
A square bar, 1¼ inch, notched one-eighth deep on its upper surface, turned to a right-angle with .	70	„
Doubled up and shut close (entirely fibrous), with	110	„
A square bar, 1¾ inch, notched in the usual manner, doubled up, being entirely fibrous, with .	87	„
From stock, a flat bar, 6⅝ inches broad by 1 inch in thickness, puddled from a mixture of pig-iron and refined metal, required to bring it to a right-angle	135	„
Turned flat up with . . .	160	„

the fracture exhibiting an entire body of fibre.

An account of the breaking of a piece of iron, of the description used for hooping the wheels of carriages travelling on railways, remarkable for hardness and tenacity (qualities pre-eminently essential in iron applied to such uses), will form a very appropriate conclusion to these experiments.

The bar in question, upon its under surface, measured 5⅜ inches; thickness, from 1¾ to 1½; with a rib raised on the outside of the upper surface about 1⅛ inch in height, which, of course, greatly increased the strength of the bar to resist impact.

A notch, one-eighth of an inch deep, was cut upon the upper surface, and forty blows of the 24 lb. hammer having produced no visible deflection, recourse was had to a double-handed hammer, the weight of which was 98 lbs.

Fifty blows of this hammer produced a deflection from a right line, equal to 1⅜.

The bar was then notched to the depth of a quarter of an inch.

Ten additional blows making no perceptible alteration, the notch was increased to three-eighths of an inch.

Ten blows more were given with a slight effect, when the notch was increased to half an inch.

Eight blows then produced a fracture, which was nearly all composed of bright-grained iron of a close steelly texture.

Those accustomed to the breaking down of iron, will at once perceive that the results now obtained, indicate generally a first-rate quality for fibre and strength, though made from hot-blast pig iron; and that no favour was shown, inasmuch as the ends, and not the middle of the bars, were made the subjects of trial.

Appendix.—Summary of the Results of the Experiments.

The lowest specific gravity found in the course of these experiments was 6·836, and the highest 7·4, the first being *gray*, and the last *white* iron. The specific gravity varied in every specimen, even from the same cast of iron. The breaking weight of the lightest of the specimens above mentioned was 484 lbs., and of the other 456 lbs.; the resistance to impact being in the former 746 lbs., and in the latter 456 lbs., and the deflection on breaking, 1·54 inch and 1 inch. The bars were, in all cases, 1 inch square, and 5 feet long; 4 feet 6 inches between the bearings.

Bars obtained from the same cast of iron varied as follows:—

No. of Bar.	Specific Gravity.	Breaking Weight in lbs.	Deflection in Inches.	Impact.
Gray mottled cold-blast iron	6·893	512	1·185	607
	6·899	540	1·22	659
	7·041	400	·84	336
	7·267	456	1·0	456
	7·333	288	·6	173
	7·4	456	1·0	456
Softer cold-blast iron	6·927	400	1·1	446
	6·992	456	1·225	559
	7·043	498	1·3	648
	7·170	400	1·2	480
	7·215	470	1·125	529
No. 3 hot-blast iron	6·923	554	1·5	831
	6·948	561	1·61	915
	6·985	456	1·3	593
	7·068	512	1·55	794
No. 1 iron, from the blast furnace	6·9	450	1·74	783
	6·975	470	1·62	762
	7·126	442	1·6	708
No. 3 iron, ditto	6·836	484	1·54	746
	to	to	to	to
	7·231	414	1 40	580

These experiments establish the fact, that the cohesion of cast-iron is not in the ratio of its specific gravity, many of the specimens in the foregoing experiments having been found the strongest, when the specific gravity was the lowest. On the other hand, the elasticity of cast iron, and its powers to resist an impulsive force, seem, from these results, to be almost uniformly at a maximum when the specific gravity is the lowest.

It may be inferred from others of the same series of experiments, that iron re-melted in an air-furnace, is considerably stronger than iron re-melted in a cupola, and that the strongest qualities are found in Nos. 3 and 4 iron.

A SERIES OF REPORTS ADDRESSED TO THE CORPORATION OF BOSTON, ON THE IMPROVEMENT OF BOSTON HARBOUR.

(*Continued from p. 272.*)

REPORT BY MR. LEWIN.

Witham Office, Boston, May 10th, 1841.

GENTLEMEN,

IN pursuance to your directions communicated to me by his worship the Mayor, I have carefully examined the several reports that have from time to time been given as regards the state of Boston Haven, from the Black Sluice to the New Cut, and embankments between Toft Jetty Point and Hobhole, in which there are many valuable suggestions made, confirming what has long ago been reported upon, over and over again, that is, the necessity of making your sea channel as straight as it can possibly be made, so as to confine the flood and ebb waters, both from the sea and land floods, in one direct line, which no doubt will greatly improve the navigation as well as the drainage; and to carry this desirable object into effect, Mr. Valentine, one of the members of your council, has laid down a line upon a plan, and made a report upon the same, in which he has included a mass of valuable information, that could only have been collected from a long and intimate acquaintance with the subject.

Mr. Reynolds, your surveyor, has likewise laid down a line of channel, and has given me much useful information on the matter. I have taken the above suggested lines, and compared them with the lines laid down by the late John Rennie, and with the lines laid down by the present Sir John Rennie, between Maudfoster Sluice and Toft Marsh Bank, and the difference is so trifling, that in following out or adopting any of the lines, I believe that scarcely any difference would be made in the general effect of the improvements; and with the view of fully examining the subject in all its bearings, I, in company with his worship the Mayor, Mr. Valentine, and Mr. Reynolds, have carefully examined both the east and the west sides of the Haven, and the different channels between the Black Sluice and Hobhole Sluice, and after duly considering the subject, I beg leave to report as follows:—

It appears to me, that the principal defect above the New Cut at present exists between Maudfoster Sluice and Toft Jetty Marsh, and if the lines of channel laid down in Sir John Rennie's plan between these points were fully carried into effect, I have no doubt they would remove all the obstructions complained of; the lines referred to commence on the eastern side, with a gentle curve, from the east wing wall of Maudfoster Sluice, and are carried from thence in a southerly direction, to within 230 feet of Pudding Pie point, terminating at the corner of the sea bank, at the western extremity of Corporation Marsh, adjoining Toft Marsh; the western side of the proposed channel passes the corners of Church Point and Rush Point, and is continued from thence in a southerly direction, increasing in width until it joins the work already laid down; and as all parties seem to be of one opinion, as to the proper lines under the present circumstances that should be adopted; the next consideration is, as to the best and most economical manner of executing the work necessary to obtain the desirable object. Upon this subject there is generally a great diversity of opinions, particularly as the nature of the neighbouring materials or the locality may dictate. Under all the circumstances, I am of opinion, that the works in the first instance should be confined to the eastern side between Maud-

foster Sluice and the corner of the bank at the western extremity of Corporation Marsh: by so doing you will get rid of two bends or set that operate very powerfully in the changes of the winter and summer channels, and the ebbs and floods will be confined to the western side, from opposite Maudfoster Sluice to Rush Point and Corporation Marsh, and the set of the floods will be altered by the removal of part of Corporation Marsh, as the flood tide now sets in a line with the western side of Corporation Marsh in a N.N.W. direction, for a distance of 220 fathoms beyond the side of the marsh; it then takes an E. N. E. direction towards the middle of Corporation Marsh, and from thence it takes a northerly direction to Pudding Pie Point; from this point it sweeps round in a N. N. W. and a N. W. direction to Maudfoster Sluice, and by adopting the eastern line first, these sets will be removed, and the working will take place in the line of the fascine work that has been already laid down on the western side, from Rush Point and Hill Marsh Jetty, and as the channel forms itself in the proper direction on the west side between the points of the fascine work above mentioned, it should be encouraged to keep there by assisting the work with additional kids, &c., as the case may require.

In executing the work to form the eastern line, it will be necessary to begin (if the means can be obtained,) to lay the fascine or kidwork at the eastern wing of Maudfoster Sluice, and to gradually bed the same in the channel in the proposed line on the sand or silt, from 2½ to 3½ kids wide upon the bed, the kids to be well secured with clay, which must be boated from Corporation Marsh, and at all vulnerable points that appear to require a material to protect it of a more powerful nature, old vessels or stones could be applied to counteract any dangerous inrun upon the new work.

I consider it will be cheaper to begin the work at once at Maudfoster Sluice, and continue the same simultaneously towards Corporation Marsh, if materials can be got to complete the same, for if the work is begun at Pudding Pie Point, it will be necessary to make a jetty of at least 230 feet long of fascines, which, with clay, stones, &c., would cost at least from £500 to £600, which would be useless when the channel is formed to the jetty, though circumstances might arise in the progress of the work, that would oblige you to make jetties for the security of the same; and as the line of fascine work is proceeding with, it will be necessary to begin to cut away Corporation Marsh, and to form the channel through the land, a great quantity of the upper surface might be removed by carts to the line of the new embankment, and laid upon and at the back of the kids, that should be laid down and secured by stakes in the line required; getting the marsh excavated to the required depth, as originally laid down, will be a work of great difficulty, but at present I think it will suffice if the bottom of the cut was excavated to a depth of five feet below the present low water in the channel, leaving the bottom about three feet above the level of Hobhole Sluice cill, and as the other parts in the silt, &c., deepened, as they will do when the channel is confined, the clayey parts might be removed by dredging. The total length of the eastern side, from Maudfoster Sluice to the corner of Toft Marsh Bank, next Corporation Marsh, is 6200 feet, or nearly 1¼ mile long, and I calculate to line this side with kids, and raise them about 5 feet above low-water mark, and cutting through the Corporation Marsh, will cost about £11,178, and the fascine work on the west side, I calculate, will cost about £3960, making a total sum of £15,138.

In executing the work, it will be necessary to keep raising and securing the kids as the accumulation of silt takes place at the back of the same, and when they have been raised to the specified height, they should be covered with rough flat stones, and secured by stakes with willow bands, so as to have the top secure, and prepared to form a pathway, which would be useful at the ebb tides, until such times as the channels have permanently formed themselves, and the sand has silted up high enough to be further embanked, and the tidal water is shut out from the same.

I have no doubt when the channels before described are trained to the lines recommended, that the work will be found of the greatest advantage to the navigation, and will materially assist the drainage of all the lands that drain by the several sluices above the same, though during the execution of the works, and the cutting away of Corporation Marsh, it is very likely that a larger accumulation of deposit may take place in the river above the works, and will remain there until the winter freshes become powerful enough to remove it, above which, and when the works are completed, the deposit in the town part of the river will be very trifling.

I further beg to state that, previous to completing the inspection of the river, I recommended that some poles or sights should be erected, showing the distance from the shore and line of the new channel between Toft Jetty Point and Maudfoster Sluice, which have been put up, and with some alterations they will be in the line I have described, and I think it will be better that they should be firmly fixed where they can be left with safety to the navigation, as they will materially assist your principal engineer when inspecting the line, and remove all doubts, and prevent mistakes as to the line that should be followed, in executing the fascine work.

I remain, Gentlemen,
With the greatest respect,
Your most obedient servant,
WILLIAM LEWIN.

REPORT BY MR. RENNIE.

London, June 19th, 1843.

Gentlemen,

In consequence of a letter which I received from Mr. Lewin, dated the 6th instant, informing me that he had received your directions to come to London for the purpose of laying before me his plans, estimates, report, and specification for the improvement of Boston Haven, between Maudfoster Sluice and the new bank across Bell's Reach, in order that I might communicate to you my opinion thereon,

I informed Mr. Lewin on the 10th instant, that I should be ready to meet him upon the subject on the 14th instant, and he accordingly came, and I employed the 14th and 15th in company with him, in examining and considering the documents before mentioned, and since that time I have further considered the subject, and will now therefore proceed to give you my opinion, as far as I am able; at the same time I think it right to observe, that in consequence of my not having seen the haven, and the works which have been carrying on for its improvement for some time past, I am scarcely able to point out what is necessary to be done in order to complete the improvement, without a personal view; if, therefore, this report should not be so complete and satisfactory as could be wished, I trust you will make an allowance accordingly.

The improvement of Boston Haven, between the town and the sea, has been a very desirable object to be accomplished, and many and various have been the plans proposed to effect it.

The late Mr. Rennie, in the year 1800, previous to the drainage of the East, West, and Wildmore Fens, strongly recommended two plans for that purpose, the one to make a cut from Boston direct to the sea at Clayhole, wholly to the eastward of the present old channel, and the other to improve the old channel by straightening its course in a direct line as far as Barton's Marsh, and from thence to make a cut across it to Hobhole and Clayhole. Either of these plans would have well answered the desired objects, and it is much to be regretted that one of them was not carried into effect at that time, but various circumstances, which it is now unnecessary to mention, occurred, so as to prevent the accomplishment of either one or the other plan.

The drainage of the East, West, and Wildmore Fens was completed in 1806, and the improvement of the haven, which ought to have preceded it, was deferred; in the mean time, the haven, when left alone to the efforts of nature, as might have been expected, instead of improving, grew worse.

The channel, left to itself, was continually in a state of change, and the current, according as the land freshes or tides prevailed, moved from one side to the other of its bed, which was far too capacious for the water which had to pass over it to maintain, because divided into numerous small ineffectual streams.

This, combined with the great quantity of alluvial matter brought in from the sea and elsewhere, so completely paralyzed the efforts both of the tidal and fresh waters, that they were unable to maintain any fixed or regular channel to the sea, and in consequence both the drainage and navigation suffered to such a degree, that in 1826 neap tides scarcely reached the town, and it was only after a long succession of floods that the waters draining over the extensive districts of low lands in the valley of the Witham, could force a passage to sea, after having caused considerable injury.

Had this lamentable state of things continued much longer, the navigation would have been lost; Boston would have been no longer a port, and the valuable and fertile districts by which it is surrounded would have reverted to their ancient state of unproductive marshes.

The interests at stake were too great to be neglected; the Corporation of Boston came forward with their accustomed spirit and energy, and resolved to grapple with the evil unassisted, although with great justice they might have called for co-operation on the owners of the adjacent lands, who, by the loss of their drainage, were equally interested in finding a remedy.

The evil, as I have already mentioned, arose from the irregular

and circuitous course of the haven itself, the unequal and disproportionate width of the channel, over which the flood and tidal waters passed, and the great quantity of loose shifting sands with which the channel was encumbered.

In the year 1827, the Corporation did me the honour to ask my opinion as to the course most advisable to be pursued in this dilemma. I accordingly reverted back to the simple principles laid down by the late Mr. Rennie, in the year 1800, and modified them according to the existing circumstances, and recommended that the channel should be straightened and confined to one and the same course, so that the distance being reduced, the fall per mile would be proportionally increased, and the flood and fresh waters, by always passing over the same channel, would act with more effect, and keep it open to the required depth; and as the greatest obstacle existed between Hobhole and Bell's Reach, in consequence of the circuitous course of the haven round by Wyberton, I recommended that this part of the work should be commenced and carried into effect in the first instance, by making a cut through the Marsh, and an embankment across the old channel at Bell's Reach: it was accordingly undertaken in the year 1828, and was completed in the year 1830; the result was most beneficial, as I anticipated, and fully answered my most sanguine expectations.

The tidal waters reached Boston considerably earlier, in consequence of the course which they had to travel having been reduced from 6 to 4½ miles, and by acting so much longer upon the reduced distance, had a much greater effect in scouring it out, and for the same reason the fresh water passed off with greater rapidity, so that by this means both drainage and navigation derived the greatest benefit, and about a year after the cut had been opened, the flow, both at neap and spring tides, had so much increased by the scouring out of the channel upwards, that square-rigged vessels of considerable burden, drawing 13 feet could come up to Boston at neap tides; whereas, previously, small sloops had the greatest difficulty in making their passage at spring tides.

The result of this work having proved so satisfactory in every respect, all parties were desirous of carrying it out further, so as to complete the improvement of the remainder of the haven between Maudfoster Sluice and the new cut above mentioned. Some time, however, was necessary to accumulate funds for this purpose, but in the latter end of the year 1835, it was determined to complete the improvement of that portion of the plan, between Toft Jetty Point and the north-east end of the new cut, which was most required, on account of the circuitous course of the channel in that part, and the eddies which were occasioned both in the flood and ebb, much to the injury of both drainage and navigation, although the latter suffered most, and one or two vessels were unfortunately wrecked in consequence.

This desirable work was accordingly undertaken and completed, I believe, about two years afterwards by your own surveyor, and although even as at present executed, it forms a great improvement, nevertheless, it is to be regretted, that the line laid down in my plan of the 12th of July, 1833, had not been more strictly followed, as the channel would have been more direct and much more effective.*

Since this last work has been completed, two inner works have been undertaken and finished, the one immediately opposite Toft Jetty Point, consisting of a jetty about 290 feet long, and a line of fascines or kid work extending upwards from the outer end of it to a distance of 1300 feet, and another from Rush Point extending towards it about 1050 feet long.

The former of these works also deviated from my line, and so far therefore is not so efficient as it otherwise would have been, at the same time it also has produced some benefit, and by an alteration at the upper end when the other work comes to be carried into effect, may be greatly improved at a trifling cost.

The upper work also, although later than the former, is susceptible of improvement.

Having now retraced the history of the operations, and their effect from their commencement up to the present time, I will proceed to point out what under all the circumstances appears to me the most advisable course to be adopted, for the completion of the improvement of the remainder of the channel, between Maud Foster Sluice and Toft Jetty Point.

The Reports of Mr. Valentine and Mr. Lewin upon this part of the subject I have read with much attention: they contain a great mass of valuable information, and display considerable acquaintance with the subject.

From these it appears that the flood tide now sets in a line with the western side of Corporation Marsh, in a W.N.W. direction, for a distance of 1680 feet beyond the side of the marsh; it then takes an E.N.E. direction towards the middle of Corporation Marsh, and from thence it takes a northerly direction to Pudding Pie Point; from this point it sweeps round in a N.N.W. and a N.W. direction to Maud Foster Sluice; whilst the ebb current, after leaving Pudding Pie Point, sets in a S.W. direction to Church Point, then in a S.E. direction to Corporation Marsh for about 1500 feet; it then keeps close to the Corporation Marsh in a south direction as far as the Corporation Point, and then strikes in the same direction right across the channel to the upper end of Hill Marsh; it then turns almost at right angles to its former course, and proceeds to the jetty and fascine work opposite Toft Jetty Point above described.

From this it is evident that Corporation Point forms the principal obstacle to a direct course, and is the chief cause of the injurious irregularities and sinuosities in the channel above mentioned.

The first attention therefore should be directed to this point, and the line between Toft Jetty Point and Maud Foster Sluice should be carried as nearly as practicable to the line originally laid down by me in 1833; and comparing it with that now proposed by Mr. Valentine and Mr. Lewin, I find that it is nearly the same: it is very satisfactory therefore to find that we all agree in the important point.

The next question therefore, is the best mode of carrying this line into effect.

As I have already observed, Corporation Point is the principal obstacle: this point must therefore be cut to the fullest extent practicable, so as to bring it to my line of 1833.

In the first instance Toft Jetty Point should be set back to the required line, the Marsh then in front of it should be excavated down to 5 feet at least below the present low-water mark, as recommended by Mr. Lewin, and if it can be carried any deeper without materially increasing the expense, which will be determined as the work proceeds, it will be better to do so.

This work when effected will give material relief, but whilst it is in progress it should be assisted by other works both on the east and west sides: those on the east side should consist of a line of kids or fascines from the eastern wing wall of Maud Foster Sluice; these should be worked in a line to correspond with the excavation at Corporation Point, and in order to keep up the effect of these two works another jetty should be projected from Pudding Pie Point: this can be extended in a direction north and south, towards the other two works, more or less as the effect produced by them requires it, and the clay which comes from the excavation at Corporation Point will be of essential service in completing the other works, to which it should be transported where necessary.

With regard to the works on the western side of the channel, these should be commenced by taking off the angle at Church Point, the back of which should be set back so as to produce an easy curve, both for the channel above and below.

From the junction of this curve with the straight line below it, the rest of the line of bank between Church and Rush Points is sufficiently near to the new intended line as to require nothing further, than that the foreland should be adjusted to it: this may perhaps be effected by the current above, with very little other assistance.

In carrying this work into effect, care will of course be taken to give the requisite facility for the operation of Maud Foster Sluice.

The line of fascines or kid work already executed from Rush Point downwards, should also be extended in the direction of the new line, so as to follow or rather gently direct the line of current, as it forms at Corporation Point.

The kid work also, now executed in front of Hill Marsh, should be extended upwards gradually to meet that at Rush Point, and in the event of the current showing a tendency to take its old course across the channel immediately opposite Corporation Point, it may be necessary to commence some kid work immediately opposite to it, and to work both ways to meet the lines from Hill Marsh to Church Point, before described.

The adoption of this, however, will depend upon circumstances, as the work proceeds.

With regard to the construction of these works, they should consist of excavation, kids or fascines, stakes, watling, clunch stone, and probably one or two old vessels, adapted to the particular circumstances of the respective places when they are constructed; Mr. Lewin has detailed them sufficiently near for the present in his specification, to enable a contractor to undertake the work at a fixed sum, and as they proceed there will be no difficulty in pointing out anything additional, if such should be required.

With regard to the estimate of the expense of carrying them into effect, I have endeavoured to make one as far as my present information will enable me to form an opinion, and I consider that the sum of £12,263 will complete the east side, and £4,550 will complete the west side, making a total of £16,813.

It may be observed that these works need not be carried higher

* This part of the work is shown on the plan by the letters B B.

than 5 or 6 feet above the level of low water of spring tides, at the respective places at present; they can easily be raised higher hereafter if found advisable; but, as the principal object is to keep the tidal and fresh waters in the same channel from the level of half tide, I trust that it will be sufficient.

I have now described generally the best direction of the intended new channel, as well as the means of carrying it into effect, at the same time I must beg to repeat, that not having seen the haven in its present state, I feel considerable difficulty and hesitation in pronouncing a decided opinion to the best course to be pursued, as regards the various points submitted to me; before, therefore, I can do so, I must request your authority to examine the haven. In the mean time, however, there can be no reason why tenders should not be invited to carry on the work generally according to the specification of Mr. Lewin, reserving to yourselves the power of making such modifications as the case may require, and which I shall be enabled to point out, after I have made a personal examination.

I am, Gentlemen,
Your most humble servant,
JOHN RENNIE.

THE LIFE AND WORKS OF CAPTAIN JOHN PERRY.

BY W. MULLINGAR HIGGINS, ESQ.

(*Continued from page* 276.)

After the Committee appointed to examine the works at Daggenham Breach had delivered their Report, Mr. Boswell appears to have had several interviews with the Commissioners, but he failed to convince them of the propriety of the works he had performed, and the period agreed on for the completion of his contract having passed, advertisements were issued for new plans and estimates.

Perry was again one of the competitors, and delivered his proposal, of which he has given the following account, one of the most interesting of the few papers he has left us.

"*The Description of a Method for the effectual repairing of the Breach in the Levels of Havering and Daggenham, according to my Proposal, humbly offered to the Right Honourable the Trustees, in the year* 1714, *and again renewed the* 29th *of November, and the* 6th *of December, the present year* 1715.

For the better understanding of my intended method, I shall first lay down two general rules or principles, which, to facilitate a work of this kind, where there is a great rise of tide and inlet of water, is absolutely necessary to be observed.

First:—That a sufficient discharge of the back water, which flows in upon the low lands, and has worn a creek, with large branches, a great way into the country, ought to be made by fixing of a sufficient sluice, at least down the depth of low-water mark, or some feet below it, whereby to ease the force and fall of the current, whilst the needful work for the stopping of the breach is carried on, which otherwise must be attended with a very expensive waste of labour, time, and materials, and to make the foundation tight and secure would be utterly impracticable.

Secondly:—Where a dam is intended to be made, in a place where the spring tides every twelve hours and twenty-four minutes usually flow 22 feet, and is (as in the case of the present breach,) by the unskilful attempts that have been made, torn and worn down in several places to double that depth below the surface of low-water mark, the greater care ought to be taken to make the foundation tight and secure, that it may not be possible for the water to penetrate either underneath or on the sides of the creek or place that is to be stopped up, for if once the water finds the least passage, especially at the foundation, where the greatest pressure of water will always be, and perhaps but very ordinary or bad ground, there will then be inevitable danger, that, either in the practice of carrying on the work, or afterwards when completed, upon the rise and pressure of an extraordinary tide, the water (though the leakage may seem but small at first) will then augment its force, and undermining the foundation of the dam, will settle down from above, and tear away all before it.

And for the same reason it is also absolutely necessary, after the foundation is secured, that the body of the dam be made and composed of such matter as may be safely depended upon to be right, and therefore by no means proper to have any ships or chests, or any sort of timber work whatsoever, sunk or laid therein, to which the earth, or matter of which the dam is composed, cannot bed close, and must be a guide to leakage. As, for instance, if but one single piece of timber be laid or placed through a dam, especially near the foundation; and where the ground is bad, the water will certainly penetrate on one side or other of such timber, and carrying always some matter with it, will soon create a hollowness in the dam, and cause the earth to settle down from above, which, upon the pressure of any high tide, must inevitably destroy the whole, and can never be trusted.

These principles being laid down, I shall proceed to show, that the dam I intend to make for the effectual stopping up of the said breach, shall first be well secured, that there shall be no fear of any leakage, neither underneath at the foundation, nor on the sides of the breach or creek; and, secondly, the body of the dam shall be entirely composed of good earth, or clayey sort of ground, from the very foundation to the top thereof, without having any sort of timber work sunk or laid therein; only I intend a row of dove-tailed piles to be drove through the middle of the dam, to secure the foundation, and upon the sides a strong drift work to be made, to be as a buttress or foot wharf on each side to keep in the earth, with which the dam is to be filled, to prevent the dam from spreading and settling out at foot; and on the outside of the said wharfs, which are to be built only a little above low-water mark, a strong wall, or foot of chalk, to be laid equal with the height thereof. The dam thus finished without any sort of timber work but what will remain constantly wet, will, with very little or no repairs, stand fast and endure for ever, and the method which I design to proceed in, in the performance, is as follows.

Near the banks of the Thames, on the starboard or east side going into the mouth of the breach, right against the place where I design to make my dam, I shall dig down a place in the firm land, for the fixing of a sluice near 40 feet broad, and for the foundation to be placed at least down to the depth of low-water mark, as before mentioned, to be made with a set of draw doors on purpose to shut down and draw up as shall be occasion. And after the sluice is thus completed a canal must be cut through, from within the dam that is to be made in the breach, to the Thames, to let the tides have their free course through the said sluice, until such time as the foundation of the dam is secured, and fixed quite across the breach to about two or three feet height above the surface of low-water mark, which I intend to do as follows.

First:—I design to drive down a row of piles as aforesaid, dove-tailed into the sides of each other, as deep as they will go, about 6 or 8 feet or more, according as the ground proves, into the foundation, quite across the creek where the breach is to be stopt up, and extending at least 20 or 30 feet into the banks on each side, the whole way, to secure the bad ground, lest the water should any where penetrate, and undermine the foundation; by the want of which being secured in the attempts hitherto made, the water has still bored under the foundation, and has been the great cause why the work, after being more than once stopt up at the low-water mark, has broke down again, and the breach been still worn broader and deeper by it; and unless this great evil of the bad ground, which is at the foundation, be rightly provided against, it is too much to be feared that all attempts whatsoever will sooner or later have the same unhappy event; and I am very positive that there is no other way in the world, whereby it is possible to secure the bad ground, but by driving dove-tailed piles; and which, though I have laid down this method, every man is not capable to put the same in practice with that truth and exactness required in the doing of it.

I design to begin first and drive the said piles in the firm land or banks on each side of the creek, and continue them on by a fair line until they meet, and shut up with the last pile in the creek or breach; and as I go on with driving the said piles, and thereby stop the course of the stream, I design at the same time to advance and carry on the afore-mentioned foot-wharves on each side, at about 40 feet distance from the said line of dove-tailed piles; which foot-wharves I intend to be made about 18 or 20 feet in breadth, to be filled with chalk and chalk rubbish, and, as they are carried on, a strong bed of chalk is to be continued on the outside also.

By reason of a free passage being made for the tides through the sluice as aforesaid, the stream will not begin to run with any considerable force in the breach until the said row of dove-tailed piles come near to be shut up in the middle, and then there will be occasion to find means to secure and support the heads of the said piles, against the weight of water which will (as the tides set in and out) begin to

be pent higher upon the ebb on one side, and on the flood on the other, and for which, nevertheless, an opportunity must be taken to shut the said piles at the dead of the neap.

The time which I design to carry on the said works, will only be at the latter part of the ebb, and the first part of the flood, when the tides, being much below the surface of the land, and having communication only with the creek or arms cut and worn into the land by the breach, will have no great power, till risen to a greater height; and I shall leave the heads of the rabbitted piles not above a foot or two above the ordinary surface of low-water mark, and those belonging to the foot-wharves but very little higher, so that when the tides come to rise and spread upon the low land, and set either in or out of the breach with any considerable force, there will then be depth enough for the water to run over the tops of the said piles, besides having a free passage through the sluice until all the piles are drove from side to side, and the breach quite stopt up at low water.

The said dove-tailed piles must be made about seven inches thick towards the sides, and eight inches towards the middle of the dam, where the water is deeper, and being jointed the whole way into the sides of each other, they will be like one solid piece, or sheet of timber, driven at least 6 or 8 feet into the ground, both quite athwart, and into the banks on the side of the breach or creek, and being made of fir timber will swell and be tight; as I have experienced the practice of in the Czar's country, where I have had from 20 to 26 feet pressure of water more upon one side of my dam than upon the other, and have been obliged sometimes to fix my works in ground that has been very bad, and yet my dams have not leaked, nor been destroyed by the floods, which in that country are very powerful, upon the sudden melting of the snow in the spring of the year. The particular engines and stages to be used, and the manner of driving the said piles regular and true, as also after what manner to support the heads of them when they come near to be shut up, I am ready further verbally to explain, if required of me.

As the said row of piles are drove through the dam, and the course of the stream thereby stopped at low-water, the filling of the foot-wharves with chalk, as afore-mentioned, must be continued, and all the way between the said foot-wharves, the body of the dam must be filled with the best sort of earth or clayey ground that is nearest at hand, and to prevent and gradually take off the force of the tides setting in and out of the breach, after the dam is once stopt at low-water, and carried up to a greater height, then, every tide the doors of the sluice must be constantly shut down, to pen the water wholly in, just when ebb'd off equal with the height the dam is raised to in the carrying up of the work, as also must be observed upon the tide of flood: when the water is risen to the same height without in the Thames, as it is penned up to within in the breach, the doors of the sluice must be immediately drawn up, that the tide may equally swell within as well as without the breach, and thereby ease the fall of water in the running of the tides over the top of the dam.

The dam, after once stopt at low-water, may be considerably advanced every tide, when it is weather for men to work, and will not require many weeks to raise the same high enough to shut the tides wholly out of the low-land, sufficient hands being employed for it.

But since it is certain that, beside the injury to the navigation of the river, the difficulty and expense of making good the said breach in a place that has so many times given way, and is so much destroyed, will be abundantly greater than if it had happened in any other part of the banks of the Thames, so much the more care ought now to be taken that the same may never be in danger of breaking out again any where in or near the present breach, therefore, it will be necessary to raise both the said dam and the banks adjacent to be (after well settled) at least a foot or a foot and a half higher than any other place of the levels, so that, although the tides should happen by any violence of weather to rise higher than was ever yet known, and quite overflow all the banks of the Thames, it may never endanger doing the same any hurt, for in case of such a tide as is supposed, where the water once takes power, the violence of the stream is always strongest in the lowest place, and only where it first gets over, there it presses with ungovernable power, destroying all before it; whereas, at such places that are made higher, though also happening to be overflowed, yet the tides, by first running over the low places the length of the whole level, will have filled the marshes, and the water becoming on a level, can move with no fall or force of the current, either upon the flood or the ebb, to break down or do any damage to such places that are raised higher than the rest of the banks, provided there be no leakage at the foundation, to cause the same to settle down by any force of the tides.

Thus, I have proposed my work, first, To be made effectually secure at the foundations.

Secondly, To be made in that order, and composed of such materials, that will not be subject to rot and decay.

Thirdly, That, although the floods and storms should happen to be greater than was ever yet known, the same to be so finished as not to be endangered thereby.

Lastly, When both the said dam is completed, and the adjoining banks raised to the height that is required, then the aforementioned canal to be made for the discharge of the back-water, must be also effectually stopt up, and the sluice broke down and taken away, for otherwise the sluice, when once decayed, would give way, and endanger the making of a new breach.

Thus I have fully laid down my intended method as to all the main and most material points for the performance of the said work, with my reasons about the same. And anything else which may not be rightly understood, I am ready further verbally to explain (if commanded), on condition that no other person shall afterwards be employed upon the same without my consent, according to my several proposals delivered to the Right Honourable the Trustees, on the dates above-said.

London, December 12, 1715.

The Trustees, conscious of their inability to decide upon the merits of the plans submitted to them, involving a question which was then one of great engineering difficulty, invited the assistance of the most eminent practical government officers, Brigadier Richards, the Surveyor General of the Ordnance; Mr. Acworth, the Surveyor of the Navy; and Colonel Armstrong, "first Engineer of Great Britain." By these gentlemen it was unanimously agreed, that the breach could not be so certainly stopped by any of the means suggested by the competitors, as by the dovetailed piles proposed by Captain Perry. The only doubt in the mind of any person present was, whether "in the violence of the stream, which set in and out of the breach, such piles, beginning at each end of the dam, could be brought by a straight line, in the depth of 20 foot of water, taking the time of low-water for it, to meet in the middle of the breach, and be out of winding, viz., the heads and the points to be parallel to each other, in the same continued line as first drove down, so as by one single pile at the last to be entered at the heads of those on each side, to join close into the grooves made for it in the driving down, and make an effectual shut like one entire sheet of timber." This objection is such as we may suppose would have arisen in the mind of any man of practical science, and in fact it seems to have been at the first consideration almost fatal to the plan. This objection seems to have suggested to the mind of some person present, that it would be more desirable to drive angular indented piles, such as had been used by the French at Dunkirk, and at Mardyke. But Captain Perry wisely objected to the adoption of this suggestion, as he could not "apprehend any method whereby it was possible to guide such indented piles down by the sides of each other, and to keep them close joined at the foot in a continued line in the depth of water, and force of the current, which was at the breach." The dovetailed piles, he contended, entering at the head, must be in close contact "all the way down in the water, and afterwards upon the entrance into the ground, by the needful care taken to cut them with a proper shape, as is in practice found requisite." But this modification of Perry's plan was not urged with any degree of pertinacity—the Trustees and their advisers perceiving that the man was as suited to the execution of the plan he had devised, as the plan itself was adapted to the end they sought. That this was the case, is evident from the statement he ventured to print, which, although, as he confesses, in some degree

offending "against the strict rules of modesty," could not be omitted in a history which was probably chiefly intended as a defence. The following is the passage to which I allude, and for the publication of which, under his own name, he ought to be acquitted of any boasting by all who know the system of puffing adopted in the present day, and the dishonesty that lies under the mask of pretended modesty.

"One of the said gentlemen more particularly expressed, that he had seen and examined all the schemes which had been offered, and did me the honour to say, that he saw no scheme equal to mine, nor any other person equal to his own scheme, for that they had proposed doing of many things, which, upon their being examined, they were not found capable to put in practice, but in all the questions they had asked me, I had answered them like an artist, and like a workman, and that therefore it was not only the scheme, but the man they recommended. Another of the same gentlemen not only declared his opinion with respect to what I had laid down being the only probable method of performing the work, but went further, and said, that he verily believed I would do it."

(*To be continued.*)

A METHOD OF REGISTERING THE FORCE ACTUALLY TRANSMITTED THROUGH A DRIVING BELT.

BY EDWARD SANG, ESQ., F.R.S.S.A., PROFESSOR OF CIVIL ENGINEERING, COLLEGE, MANCHESTER.

(*Read before the Royal Scottish Society of Arts.*)

It is a desideratum to have the means of ascertaining how much force is actually consumed in the working of a machine. Whenever the motion is communicated by the intervention of a belt or band, this can be very easily accomplished.

When we see a belt passed over two pulleys, and look without any narrow examination at the motion, we regard the action as a very simple one: there is more in it, however, than appears at first sight. For the sake of clearness, let us call the driving pulley the drum, and the other the pulley. The belt passed over them, whether plain or crossed, has two free parts, one of which *draws* and the other of which *follows*. If it were possible that no force were needed to turn the pulley, the two free parts would be in the same state of tension; but whenever any resistance is made to the motion of the pulley, the drawing part is distended more, and the following part less, than usual; and experiments show, that, within all practical limits, this change is exactly proportional to the pressure necessary for overcoming the resistance.

As the movement proceeds, the distended part of the belt is lapped over the drum, and, so to speak, the contracted part is lapped over the pulley, so that the circumference of the drum moves more swiftly than that of the pulley: thus, if the distension be 1 in 100, for 100 inches of the drum there would be only 99 inches of the pulley passed over.

The difference between the velocity of the drum and the pulley thus indicates the pressure needed to carry the drum round. Now, this pressure, combined with the distance through which it acts, gives the force used; and hence, the simple difference between the distances passed over by the circumference of the drum and by that of the pulley, is exactly proportional to the force; and we have only to contrive some method of registering this difference, in order to have a record of the total force transmitted by the belt.

There may easily be contrived a variety of arrangements for showing the difference between the motions of the drum and the pulley. Thus, a pair of indicators may be fitted, one to each shaft, so as to tell the total number of turns made by each: from this number, by help of the measured diameter, the distance passed over by each circumference can be found, and thus the element for knowing the force transmitted can be had.

Or otherwise,—and this perhaps is the most convenient arrangement,—a light pulley, having its circumference one foot, may be brought to bear against the belt on the drum, and another against the belt on the pulley: if these light pullies have counting gear attached, a simple reading off and subtraction will give the difference of distance.

Having now ascertained the difference between the motions of the drum and pulley, it remains to ascertain by what this must be multiplied, in order to give the force. It is not my object at present to enter into the theory of the matter,—although this theory presents several points of considerable interest,—but to give a practical application of the principle. In order to find out the force due to a single foot of difference, we have to run the pulley unburdened for a considerable time, taking notice of the difference of motion, and then loading the shaft by means of a spring friction-strap with two arms, repeat the observation over as many strokes of the engine or turns of the drum: in this way we shall have a new difference, and subtracting the one from the other, we shall have what is due to the force, as shown by the friction-strap.

When the multiplier for one belt has been ascertained, that for any other belt may be approximately computed, if it be of the same material, by having regard to the relative weights of a foot of each; so that a pair of accurately constructed counters form a portable apparatus, by means of which the force transmitted by any belt may at once be ascertained, the weight, length, and material of that belt being known.

DESCRIPTION OF A MARINE SALINOMETER FOR THE PURPOSE OF INDICATING THE DENSITY OF BRINE IN THE BOILERS OF MARINE STEAM ENGINES.

Invented by J. Scott Russell, M.A., F.R.S.E., F.R.S.S.A., *Civil Engineer.*

It was very early in the history of steam navigation that the inconvenience of raising steam from salt water was experienced. When the Comet descended below Port-Glasgow in 1812, the boiler was found to boil over, or prime, as it is technically called by engineers, when part of the water is forced up so violently, along with the steam, as to pass over into the cylinder of the engine—a circumstance always detrimental, and sometimes destructive to the engines. This arises from the thickening of the water, its density being increased by the retention of the solid substances which compose sea-water, and which remain and accumulate in the boiler, while the fresh portion of the water is passing off in the shape of steam.

This process of accumulation of solid matter in the marine boiler is by no means slow. The whole of the water which a marine boiler usually contains is evaporated in three or four hours, leaving the solid substances in the cubic content of boiler behind it, and being replaced by salt water, with an equal quantity of depositary matter, accumulating as rapidly as before; and since it is known the solid matter amounts to as much as one-fortieth of the whole mass of water, it would follow, if the process of ebullition could continue so long as 150 hours, there would be deposited in the boiler a quantity of solid matter equal to the number of tons of water in the whole content of the boiler.

Long, however, before this degree of solidification can take place, evils of a different description intervene to impair and put an end to the functions of the boiler. The solid constituents of salt water which are left behind do not diffuse themselves uniformly over the whole liquid mass, so as to constitute a homogeneous brine; on the contrary, the new supplies of sea-water, as they enter the boiler, remain secluded from the former more saturated brine, rise by their less specific gravity into an upper stratum, while the denser brine forms a bed in the lower part of the boiler, and surrounds the fire-box and heater-flues occupying the water-spaces and legs, which are usually at a high temperature, and which, in double-tiered boilers, are generally the most intensely heated. The intense heat of the metal expels the water from the brine in contact with it most rapidly in the hottest places, and salt is deposited on the hottest parts of the furnaces and flues, extending rapidly to those less heated, and so not only diminishing the evaporative power of the boiler, but injuring its substance, and endangering its existence.

The remedy for these evils was very early invented. But I have not been able to discover the inventor of the cleansing process commonly called "blowing down," or "blowing off." It is almost universal, and is performed in the following way:—There is forced into the boiler, at each stroke, rather more water than is required for the supply of steam, so that the boiler becomes too full. Openings are then suddenly made at the bottom of the boiler, and the brine at the bottom being violently ejected, carries with it any solid substances that may have accumulated near the bottom—the boiler is thus

cleansed; and before the water has got too low, the openings are again closed, and the boiler continues to be fed as formerly.

Another remedy, pretty generally adopted, is the brine-pump, by which, for every portion of water supplied to the boiler, about one-fourth part of that quantity of brine is withdrawn from it. This process does not so thoroughly carry off all the impurities as the former; but it is attended with a saving of fuel by a contrivance for giving to the feed-water entering the boiler a portion of the heat of the discharged brine. The recent introduction of this process is due to Messrs. Maudslay and Field of London.

In whatever way the saturation of the water with solid matter may be remedied, it is essential to the accomplishment of this object, that some simple apparatus should be contrived for the purpose of shewing when the cleansing process is required, and whether it is successfully applied. If this be not obtained, the usual consequence of acting on wrong data are sure to follow.

A contrivance was patented, which was thought promising, but was found liable to be mechanically out of order when most wanted;—a ball of greater specific gravity than salt water was connected with an external index, by which there was indicated on the outside the fact of the brine becoming sufficiently saturated to float this ball.

Another was to place in the glass gauge of the boiler a glass hydrometer bead, which would float when the brine became saturated to a given point, and fall to the bottom in the ordinary state of the boiler. But this fails entirely of accuracy, although very elegant, for the brine of which we wish to indicate the density is in the lower stratum, not the upper one, where the usual glass gauge is placed, and irretrievable mischief might be done before the indication would shew any change.

I have lately employed, in some large ships destined for transatlantic voyages, a species of brine-gauge, or index of saturation, which is found to possess every advantage, and which I therefore desire to communicate to the public through this Society. The drawings sent are such as may enable any engineer to construct them for himself. The details of the arrangement of the apparatus were made under the direction of Mr. James Laurie, formerly one of my assistants; and he also has obliged me by writing out the annexed description of the operation of using the index.

The principle I have used is the well-known law, "that the heights of equiponderant columns of liquids vary inversely as the densities of those liquids."

If I take open glass tubes bent in the form of the letter U, as in the diagram, and pour one fluid into one of the sides, and another fluid into the opposite side (taking care to use the heavier liquid *before* the other); the one being mercury, and the other water, they will stand at the height of 1 inch and 13 inches respectively. If I use alcohol and water, they will stand at the height of 10 inches and 8 inches respectively, the height of the one fluid being always greater than that of other, in the proportion in which its weight, density, or specific gravity is less.

In like manner fresh water and salt water will stand at heights of 40 and 41 inches, shewing a difference of 1 inch.

The use which I make of this principle is as follows. I reckon the best scale of saltness of a boiler to be that which takes the common sea-water as a standard. Sea-water contains one-fortieth of saline matter. When the water has been evaporated, so as to leave only half the quantity of distilled water to the same quantity of saline matter, I call that two degrees of salt, or brine to the strength of two, and such brine would show the columns 40 and 42, or double the saltness of sea-water, indicated by a difference of 2 inches. A farther saturation would be indicated by a difference of 3, 4, 5, and 6 inches between the columns, and so indicate three, four, five, six, and any further degrees of saltness—a range which may be made to any degree of minuteness by the subdivision of the scale of inches. This scale is that which appears to me most simply applicable here—and it is that which I adopt for marine boilers.

The mechanical apparatus which I have employed to give this indication is perfectly simple, and has the advantage of being such as the engineer already perfectly understands. To the marine boiler I apply two water-gauges of glass, instead of one as at present used; they both serve the purpose of the present glass gauges, and the pair would be valuable for this, if for no other reason, that there would always be a duplicate when one is broken, an accident not unfrequent. To these gauges I simply attach small copper pipes, so that one of them may be placed in communication only with the salt brine in the lower part of the boiler, and the other with the feed-water which is entering the boiler; the one then holds a column of brine, and the other of pure sea-water, and each inch of difference shews the degree of saturation.

Without the use of any attached scale, the engineer, by a little practice, comes to know in his particular vessel what difference in inches can be admitted without danger, and at what difference of height it is imperative to blow off. But it is convenient to have an attached scale.

It may be satisfactory to state, that the practical range of scale in an ordinary boiler in the ordinary working, is 6 to 10 inches, a difference sufficiently great to be easily observed.

The rule of working them is nearly this:—Continue the operation of blowing off until, if possible, the difference of the columns is less than an inch: it will be unnecessary to blow off again until the difference is at least 6 inches.

As a practical rule, I find that it is necessary to blow off when the brine at the bottom has about three degrees of saltness. But this will vary exceedingly, according as the construction of the boilers is more or less judicious. When the heat is greatest in the lowest portion of the boiler, and the flues return above, they will be most liable to salt, and require the most frequent cleansing.

BLASTING BY FRICTIONAL ELECTRICITY.

During the past few weeks, several interesting experiments have been tried with a new invention for exploding gunpowder. The apparatus used, although merely a model or small machine for showing the principle of the invention, is capable of exploding several charges simultaneously, at distances from one to two hundred feet. The agent employed in this plan is common electricity, collected in Leyden jars. It will occur to those who know anything of electricity, that it cannot be produced save in very dry weather. The inventor, Mr. R. W. Thomson, a young Scotch engineer, has overcome this difficulty by an ingenious arrangement. He surrounds the battery and cylinder by an atmosphere kept dry by art: in other words, he encloses the apparatus in an air-tight box. The provision for drying, and keeping dry, the air in this box, is extremely simple—a small vessel containing some dried chloride of calcium being placed inside, is all that is required. So great an affinity has this substance for water, that it absorbs all the moisture from the air in the box, and quickly renders it perfectly dry. The box being air-tight, the air contained in it of course remains dry, notwithstanding the dampness of the atmosphere. The wires being previously arranged, the electricity is discharged through the bursting cartridges, one of these being placed in each bore or mine. In this plan of blasting, unlike the galvanic method, the whole of the electricity goes through each bursting cartridge, the conducting wires being cut, and the ends placed a little apart. Of course a spark takes place, and explodes the substance of which these cartridges are made.

The expense and inconvenience of working galvanic batteries, have altogether prevented their general introduction; and, although by their means the advantages of simultaneous blasting have been clearly established, yet they have proved too complicated to be used in this way, in ordinary excavating or quarrying operations. Mr. Thomson's Electrical Exploding Machine is certainly on a much more convenient and simple plan, and will quickly recommend itself to those who are engaged in excavating or quarrying works. Nor can his beautiful invention for improving the electrical machine, by placing it in an artificial atmosphere, fail to be appreciated by those who have occasion to use electricity either in the lecture-room or laboratory.—*Dover Paper*.

WOOD PAVING PATENTS.

An action was tried at the last Liverpool Assizes, for an infringement of a patent for the paving of roads, streets, &c., with timber or wooden blocks. The plaintiff was Mr. D. Stead, formerly a merchant of London; the defendants were, nominally, the surveyors of streets and paving at Manchester, but the action was really against the Metropolitan Wood Pavement Company. The plaintiff took out a patent on the 19th May, 1838, for a system of wood pavement, being an improvement on the plan adopted in Russia, and which was communicated to him by Mr. Maestrom, a Russian merchant. The patent was for an invention consisting of a mode of paving with blocks

of similar sizes and dimensions, of either a hexagonal, triangular, or square form. The defendants pleaded that the invention was not original; that it was, in principle, precisely the same as that published by Mr. Head, in 1836, and called witnesses to prove that the plan had been in use before the patent had been taken out; but the secretary of the London Wood Paving Company admitted, on his cross-examination, that Mr. Stead was the first person who had laid down wood pavement on an extensive scale in the streets of London. His lordship, in summing up, said that there was no doubt the defendants had done that which amounted to an infringement, if the patent were good, and therefore the first plea of not guilty would be for the plaintiff. In the second plea, the defendants said that the plaintiff was not the inventor. If the plaintiff obtained his information from a foreign country, that would still leave him the true inventor in this country; but if he derived his information either from books or from oral communication in this country, which had given to the public that knowledge, then he was not entitled to the patent. In his specification, the plaintiff set forth that he had derived his information from a foreigner, but he had produced no proof of that before the jury; but on the other hand, the defendants did not bring home to the plaintiff the fact of his having seen the published communications and descriptions which they alleged had enabled him to take out the patent, and the jury would therefore have to decide whether he had derived his information from abroad or from books published in this country. It would not deprive a man of an invention, if another thought of the same thing in his head at the same time, but had not carried it out into practice. With respect to several other pleas involving points of law, he decided in favour of the plaintiff. The jury returned a verdict for the plaintiff, 40*s.* damages. Since Mr. Stead's patent appeared, 49 have been taken out for a similar purpose.

IMPROVEMENTS IN THE HARBOUR AND RIVER AT GLASGOW.

Rapid progress has been making during the last two months in the works which have been for a considerable time in operation for the improvement of the harbour at the Broomielaw, and which, when completed, will amply supply the wants of the Glasgow trade for years to come. The works upon which the Clyde Trustees, by means of their able engineer, have of late been bestowing their principal attention, are—first, the new harbour below Napier's Dock; second, the new timber and small craft wharf, between the Glasgow and the Accommodation bridges; third, the additional timber wharf at the Glasgow bridge for river steamers; and, fourth, the cutting of a new deep channel through the Port-Glasgow bank. The accommodation within the harbour will be as follows:—

	Feet.
Length of quay walls already existing on the north side of the harbour	3700
Length of quay walls already existing on south side of the harbour	2300
Total present accommodation .	6000
The new quay in the course of formation on the north side, below Napier's dock	550
The new timber wharf in the course of formation on the north side, between the bridges . . .	500
Total accommodation at the Broomielaw .	7050

In addition to this, a ruble dyke has been formed on the river-side, ground recently acquired below Todd's mill; which, by the excavations made, has added a space of 100 feet to the breadth of the river for 800 feet downwards, and from which 25,000 cubic yards of earth have been removed in the course of the excavations. This, it may be observed, is only the commencement of a series of operations, which will eventually have the effect of widening the harbour from 160 feet (its present breadth at the Kinning-house Burn) to as near as may be 400 feet throughout. The excavations at this spot have already extended to nearly low-water line; but in due course it will be further operated on and deepened until there is at least 12 feet below low-water line, which at high water, in ordinary tides, will at all times afford from 19 to 20 feet in the harbour. In connexion with this subject, it is not a little curious to remark, that when Smeaton made his survey of the Clyde about 1758, he reported that the influence of the tides were barely perceptible at Glasgow bridge, whereas now, by the deepening and dredging processes which have been for some years in operation, there is an average tidal rise of at least 7 feet 4 inches, when there are no freshets in the river. In addition to these harbour accommodations, there is the basin at Bowling, situated 10 miles below the Broomielaw, which is employed for the laying up of large ships and steamers during the winter months. The basin contains an area of 14 acres; and it is three acres larger than the Prince's Dock at Liverpool. It was executed in 1841, at very trifling cost.

The extension of the harbour between the bridges, for small craft, is generally looked upon with much satisfaction. The weir, which has so long obstructed the navigation at the Glasgow bridge, has now been as near as may be removed, and a new weir has been placed down at the Stockwell bridge for the maintenance of the top level of the river for the purposes of the Water Company at Dalmarnock. The removal of the old weir has been very rapidly effected, considering that 15,000 cubic yards of stone and earth have been carried away, and from 500 to 600 piles drawn. The depth of water already obtained between the bridges at full tide, is 11 feet, and now that the weir is nearly removed, it will afford accommodation for timber rafts, and all the small craft, of whatever tonnage.

The operations during the last and present summer, in cutting a channel through the long obstructing Port-Glasgow bank, have been of the utmost importance to the navigation of the river. The cut formed by the dredging machines extends to about 700 yards in length, by 400 feet in breadth, and the result is, that while there is now a depth of 12 feet of water at low tides, there is no less than 22 feet 6 inches at high-water in spring tides. Last year 90,000 cubic yards of stuff were excavated in making the cut through the bank, and this season the excavations amounted to 70,000 cubic yards, giving a total of 160,000. This bank was one of the greatest obstructions in the river, and there have been sometimes from 10 to 15 vessels lying aground on it. Since last summer there has not been a single vessel impeded in its course in sailing over or through the new channel. In addition to the benefits which will be derived from the cut in the Port-Glasgow bank itself, it will vastly facilitate the navigation of the river in other respects, permitting the upward passage of a vastly additional quantity of tidal flow.

The works have been planned and executed by Mr. Bald, the engineer to the Trustees. In their recent improvements on the harbour and river, and in their purchases of river-side ground for further extension, when requisite, the Clyde Trustees may now be said to have almost brought to a conclusion the operations which were commenced half a century ago. And when we consider that within a comparatively recent number of years, more than half a million of money has been sunk in these operations, and that the revenue varies from £42,000 to £47,000 per annum, we may well say that there is scarcely a similar instance on record of such vast enterprise and such rapid advancement. It is interesting to look back to the records of the old historians of Glasgow, for a description of the river and harbour in early days, and, insignificant as the latter undoubtedly was 100 years ago, the citizens appear to have been then as proud of the commercial bustle of the Broomielaw as now. At least this has been the case with old M'Ure, the garrulous historian of the city, and from whose work, published in 1736, we make the following extract:—

"The next great building is the *Bremmylaw* Harbour and Cran, with the lodge for his Majesty's weights, beams, and triangles, with a fine fountain, which furnishes all the boats, barges, and lighter's crew, that arrives at this harbour from *Port-Glasgow*, with water, and all other vessels which come from the *Highlands* and far off Isles of *Scotland*, besides other places; there is not such a fresh water harbour to be seen in any place in *Britain*; it is strangely fenced with beams of oak, fastened with iron batts within the wall thereof, that the great boards of ice in time of thaw may not offend it; and it is so large that a regiment of horse may be exercised thereupon."

M'Ure, also, in noticing the rise of trade in Glasgow, has the following:—

"The merchant adventurers who succeeded in sea trading, were *John Young*, merchant, *Matthew Turnbull*, *Archibald Faulls*, and *William Simpson*, born at *St Andrews*, about one hundred years ago; he built two ships at the *Bremmylaw*, and brought them down the

river the time of the great flood. The place of our shipping in those days was the bailliary of *Cunninghame* and sheriffdom of *Air*, he traded to *Flanders*, *Poland*, *France*, and *Dantzic*, and built great houses in *Glasgow*, within the *Trongate*, with great orchyards, four large barns, and great gardens at the back thereof, lying upon the south side of the Westport Street, and bounded with the rope-work, he built likewise a great lodging in the New-Wynd."

The first quay, which was a very small one, was erected at the Broomielaw in 1668, at an expense of £1660, previous to which period there had only been a landing shore at Glasgow. Smeaton's survey took place between 1755 and 1758, in consequence of which an act of Parliament was obtained for rendering the river navigable by means of locks. This plan, however, was ridiculed by many of the citizens, and a second survey was made by Mr. John Goulburn, of Chester, who recommended the improvement of the river by means of jetties or dykes. A second act of Parliament was obtained, in consequence of which Mr. Goulburn was appointed to deepen the river, so that vessels drawing six feet of water might come up to the Broomielaw, and by 1775 he had erected 117 jetties, by means of which the river was confined, and the rapidity of the tidal flood and stream scoured the bottom, and secured the requisite depth. The dimensions of the harbour were also gradually increased, for in 1792 an addition of nearly 400 feet was made to it, and in 1811 it received a further addition of 900. The great improvements in the river and harbour have all been made in the present century, for even so recently as 45 or 48 years ago, the only vessels which approached the Broomielaw were gabbarts, or small craft under 50 tons, and at that time days often elapsed without a single keel being seen at the harbour. By 1821, however, the river and harbour had been so much improved, that ships drawing 13 feet 6 inches water could come up to the Broomielaw, and the facts stated above will give some idea of the improvements which have been made since that period. It will be observed, also, from the following statement, that, with the exception of the two last years of extraordinary depression of trade, the harbour and tonnage dues have all along continued rapidly and regularly to increase. The dues for the year—

1771 were	£1,071	0	0
1791	2,145	0	0
1804	4,760	0	0
1815	5,960	0	0
1825	8,480	0	0
1826, when 33 per cent. were added to the rates,	16,200	0	0
1830	20,296	0	0
1834	22,859	0	0
1837	35,595	0	0
1839	45,826	0	0
1840	46,446	0	0
1841-2	40,685	0	0
1842-3	42,401	0	0

MR. SPENCER'S REMARKS ON MR. ROE'S REPORT ON THE DRAINAGE OF THE TOWN OF DERBY.

TO THE EDITOR.

Sir,

Upon looking over the Report "On the Brookcourse and General Drainage of the Town of Derby," lately made by Mr. Roe to the Commissioners, a copy of which has fallen into my hands, I find that certain data, taken as the basis of a Report formerly addressed by myself to the Brookcourse Committee, are adverted to in such a manner as to cast upon them the imputation of inaccuracy. Feeling that the subject is one of great local importance, and knowing that the data in question must entirely determine the efficiency of the several alterations proposed, I am desirous of stating the reasons which induce me still to adhere to the opinion that those data are correct.

Mr. Roe says,—"I find that Mr. Herbert Spencer measured the area occupied by the flood at the highest point it reached in 1842, at a little above Nuns-street, and that area was found to be 434 feet: this may be in excess as a guide to the real area due to ordinary obstructions, from the fact of part of Bridge-street Bridge, immediately below, having been washed down, at which time, from the obstruction so caused, the flood probably attained to the highest point in that part of the town."

This sentence, if I understand it rightly, implies that the sectional area of 434 feet is greater than that which should be taken as a ground for calculation, and Mr. Roe evidently entertains the idea that as the current was artificially raised by the parapet wall of Bridge-street Bridge, some deduction ought in consequence to have been made. From this I must beg to dissent. The quantity of water passing at any part of a current is in *all* cases determined by the multiplication of the sectional area into the velocity, and it matters not what may be the circumstances which tend to exaggerate either of these conditions,—whether the level of the surface be raised by an obstruction, or its rapidity be increased by some accidental declivity of the surface, the volume of water delivered is nevertheless invariably the product of the two. The only effect produced by the increase of one factor is an equivalent diminution of the other. If the sectional area be augmented, there will be a corresponding decrease of the velocity, and an acceleration of the current will be accompanied by a proportionate lessening of its dimensions. If, therefore, the sectional area of 434 sq. feet was co-existent with the specified velocity, there could be no such error as that hinted at.

Whether Mr. Roe's estimate of the size of the current is entitled to more confidence than that which he impugns will best be seen by a comparison of the circumstances under which they were made. In the one case the dimensions were taken within three or four days after the catastrophe happened, and whilst the height of the surface was distinctly traced on the surrounding buildings. In the other the measurements were obtained more than a year after the occurrence of the flood, when all the water lines were effaced, save in those isolated places where permanent marks have been fastened. The one section was taken *above* the town, where the stream passed in an undivided mass through a single opening; the other *in* the town, where it had spread itself over a wide surface, and was rushing down streets, lanes, and courts, through houses, over walls, and making its way by every available opening. Such was the complexity of the current, with its numerous outlets and varying velocities, that when seeking data for my own calculation, I despaired of ascertaining with any degree of precision the quantity of water brought down, by reference to those sources from which Mr. Roe has drawn his estimate, even though the facilities for obtaining accurate measurements were at that time so much greater. Seeing therefore that the objection made to the sectional area of 434 feet is groundless, and that it was obtained under much more advantageous circumstances than any other could be, it may be fairly assumed that it is the nearest to the truth.

With regard to the question of velocity, there seems to be a still greater difference of opinion. Mr. Roe's mode of putting the case, however, exaggerates whatever discrepancy really exists. He says—"Mr. Spencer collected the opinion of several individuals, and they considered the velocity to be from 9 to 10 miles per hour; whilst others of whom I inquired gave their opinion as at 5 miles per hour, and some less than that. * * * * * * * My own opinion is, that if the velocity of the current had been taken, it would not have been found to average more than about 3½ miles per hour through the town."

From this it would be naturally concluded by every reader that Mr. Roe was comparing different opinions respecting the same circumstance. But such is not the fact. The velocity of 9 or 10 miles per hour is that which was observed *above the town* at the point where my section was taken, whereas the velocities with which it is compared have reference to the current in its passage "*through the town*," where its rapidity was by no means so great. Mr. Roe must surely have been aware of this disagreement in the conditions, and should have mentioned it. Unless indeed he really believed that the rate per hour specified by me was that noted during the passage of the water through the town—a belief which involves the supposition that I had estimated the volume of the flood by measuring the sectional area at one point, and combining it with the velocity observed at another—a somewhat unwarrantable assumption.

That this explanation is sufficient to account in great measure for the difference of opinion respecting velocity will be seen by calling to mind the accelerating influences acting upon the current in the one case, when contrasted with the retarding ones in the other. The surface over which the water flowed before reaching Mr. Duncan's mill, at which point the section was taken, had a very considerable inclination, whereas after its entrance into the town it had to make its way over comparatively level ground. Moreover, the water way in the

one case was such as to afford every facility for the passage of the current, averaging, as it did, from 10 to 12 feet deep, occupying but a moderate breadth, and opposing no obstacles to the progress of the torrent, by which circumstance the friction was greatly reduced, whilst below this point the water had not only to spread itself over a broad channel, and thereby meet all the extra resistance to which shallow streams are subject, but had also to encounter multitudes of barriers, in the shape of houses, walls, bridges, and so forth. In the one case the accelerating forces were at a maximum, and the retarding ones at a minimum, and in the other exactly the reverse.

Leaving this part of the question, and assuming for a moment that the cases are comparable, which they are not, it may yet be well to ask which of the two sets of opinions, gathered by Mr. Roe and myself, is the most worthy of credence. His statement is founded upon the recollections of parties appealed to somewhat more than a year subsequent to the occurrence. Mine, on the other hand, was drawn from the opinions of persons questioned within three days after it; and certainly, according to our ordinary notions of memory, the vivid impressions of three days old are the more likely of the two to be correct, especially when the idea was one so difficult for the imagination to call up as the *remembrance of a velocity*. In what manner Mr. Roe questioned the individuals whose opinions he obtained he does not say; but it may be well to state, that in gathering the impressions upon which my statement was based, care was taken that the parties should not be led into error by the vague question, How many miles per hour do you think the stream flowed at? for few could give a trustworthy answer to such a question, but they were led to compare the velocity with their impressions of known velocities, and they uniformly agreed in the assertion that sticks and logs of wood were carried by *as fast as a man could run*. It was on this authority that the speed was taken at 9 or 10 miles per hour.

Confining the question, however, to the velocity of the current in the town, it is not easy to discover how it happens that Mr. Roe should, after all, have decided in favour of so low a velocity of 3½ miles per hour. The usual course adopted, where there is any disagreement of data, is to assume the mean as most likely to be correct; and on what authority Mr. Roe, after collecting statements from various sources, rejects them all, and puts forth one of his own, lower than the lowest, it is difficult to imagine. Some of the practical effects of the flood are certainly unfavourable to his opinion, for it is hardly probable that a current, with a velocity of only 3½ miles per hour, would tear up pavements and give various other like manifestations of its power.

Even setting aside the arguments here brought forward, I believe it may be proved from existing circumstances that the rate per hour at that part of the stream where the original section was taken could not have been anything like so low as Mr. Roe imagines, for I am under the impression that—given the inclination of the surface above Mr. Duncan's mill, together with the sectional area of the water-way, it may be proved to a mathematical certainty, that the velocity could not, whilst the laws of nature remain as they are, have been far from that specified.

With your permission I should be happy to make some further remarks upon the subject, relative to the cost and efficiency of the proposed schemes.

I am, yours respectfully,
HERBERT SPENCER.

London, September 19, 1843.

THE BAR HARBOURS OF THE SOUTHERN COAST OF ENGLAND. BY W. B. PRICHARD, ESQ., C.E.

TO THE EDITOR.

SIR,

It was somewhat unfortunate for Mr. Brooks that his attack upon me, which appeared in your last Journal, should have been accompanied by full length copies of the documents he referred to; containing certain matters connected with the correspondence between us, which it would have been very convenient for him to have kept in the back ground. Upon comparing the extracts made by him from our letters with the letters themselves, your readers must have perceived, that there were other motives, besides the regard for "brevity," which induced Mr. Brooks to refrain from making more copious quotations; probably the reluctance to expose his new mode of obtaining practice might have had some influence in forming his decision. Or, perhaps, it may have struck him that his case could not have been made quite so satisfactory if all the circumstances had been stated. But, whatever may have been his reasons for omitting some *important* parts of the correspondence, it is certain that the circumstance has an *awkward appearance*.

It is not difficult to account for the use of similar expressions by Mr. Brooks and myself in writing upon similar subjects. I have very carefully studied the original works of Guglielimini, Eustace Manfredi, Torricelli, Grandi, Ab Gwilim, Pryddarch, and other writers upon the motion of water, and on looking over Mr. Brooks's book, I have no doubt that he has consulted the translation of "Frisi on Rivers and Torrents," who quotes largely from the authors I have named, if he has not read the authors themselves. We have, therefore, insensibly adopted similar terms and comparisons, and each has made use of them in treating of analogous subjects. Presuming this to have been the case, and remembering, at the same time, that the questions we have both written upon are of a kind hitherto much neglected, and which admit of but little variety of phraseology in their exposition, it will be seen that there was a great probability of sameness in our explanations, and of a similarity in the mode of expression.

But putting aside all other considerations, I think it will be admitted by every unbiassed person, that if I had been really inclined to play the plagiarist, it would have been most injudicious policy upon my part to have made use of forms of expression bearing any resemblance to those employed by Mr. Brooks. Common sense would have suggested the precaution of so far modifying them as to prevent the possibility of their being detected, and nothing would have been easier than to have done this.

Leaving these observations to have their due weight with the reader, I will at once proceed to the examination of Mr. Brooks's remarks, and point out the difference between his *Ideas* and my own.

First, compare page 5 of my Report, and page 1 of Mr. Brooks's book. Mr. Brooks commences his work by reference to rivers encumbered with bars (excepting those invested with shingle beaches), and speaks of the subject as one of national importance. He then proceeds through the chapter, much of which is quotation, to describe the theories which have been proposed or supported by different writers.

But in page 5 of my Report, after stating to the Commissioners how imperfectly the formation of shingle bars was understood, I also observe that works of great magnitude have been undertaken for the purpose of removing them, but in that remark I refer solely to the shingle bars on the coast, viz. Dover, Folkestone, Rye, Newhaven, Shoreham, Littlehampton, &c. Throughout my Report I have only noticed the harbours with shingle bars, and Shoreham in particular.

Has Mr. Brooks the *presumption* to imagine that no other person but himself has a right to consider the subject of bar harbours, as one of great importance to mankind: or that no engineer is to assert that such and such is the fact, in practice, because Mr. Brooks alleges, that he has promulgated similar doctrines in theory?

The next comparison made by Mr. Brooks, is between page 12 of my Report, and page 22 of his book. Here again, Mr. Brooks promulgates the theory, that *if* the low-water channel of a river be irregular at its embouchure, that condition will be sufficient to cause the formation of a bar; but the cause is purely supposition.

It is assumed that such a river may exist somewhere or the other, but no example is given, nor a section of such a river, nor is it stated what is to be the remedy for rivers presenting different sections, or inclinations, except it be an universal application (like Morison's pills,) to all grades of evil.

In page 12 of my Report, however, will be found the following sentence. "The next subject that I shall refer to, as being the cause of the roughness and swell in the western arm, is, as on referring to Section, No. 1, you will perceive, the great declivity and irregularity of the bed of the channel; the blue colour shows the depth of water at average spring tides, also the line of the bed; the upper part of the Section, is the tidal lines maintained at the flow of the tide, showing the time at which each tidal line was taken, and the number of minutes and seconds required by each division of each tidal line to travel the distance on the Section, from which you may gather the velocity of each tidal division, and the number of tons and gallons of water entering the harbour at a tide, and the hydraulic pressure maintained, which is a fact that ought to be in the possession of those having the management of tidal harbours, and is of great importance to them."

Had Mr. Brooks quoted this, it would have been clearly seen that I was speaking of a *fact*, and not of a *theory*. It is expressly stated, that the violent return of the back-water, resulting from the great declivity and irregularity of the bed, dams back the flood tide as shown by the tidal line on the Section. How then can the passage alluded to be a plagiarism upon Mr. Brooks, where it is an explana-

tion of a visible circumstance coming under my own observation, and which circumstance he probably never had the opportunity of witnessing in the particular case in question. I must have said what I did, or have stated what I knew to be false; and because I chose to bear witness to the truth, Mr. Brooks accuses me with piracy.

Mr. Brooks next compares page 13 of my Report with page 69 of his own: here, as before, he attributes the formation of bars to the great declivity of the bed of the river, while I state, that the great rise of the bed, from the entrance to the railway quay, is only an *auxiliary* to the formation of the bar (here again, Mr. Brooks speaks supposition, while I am treating of facts), and not the main or principal cause. The following extract from the same page of my Report will show you that Shoreham Harbour has an extraordinary irregularity and inclination at its entrance, viz:—"I wish here to impress upon your minds, that there is not an instance in Great Britain of a harbour having so much fall at its entrance as this harbour, and most likely not in the whole globe: our noblest harbours and rivers, the Thames, Mersey, Clyde, Dee, Avon, and Tyne, &c., have not as many feet in miles.

"The consequence is inevitable, that as soon as the flood tide has gained sufficient head above old Shoreham bridge, and the limits of your harbour, and expands on the marshes, the tidal currrent runs (as shown on the tidal section) with great rapidity past those wharfs, quays, &c. just as vessels are lifted from the ground; such, in fact, as any harbour, where vessels lie at their berths, ought not to be subject to, especially where those quays are acted upon by the ingress and egress of the tides." It was from this peculiar circumstance that I stated it to be an *auxiliary* to the formation of the bar. But if the channel of Shoreham harbour, or any other harbour on the coast, were reduced in its inclination to as many inches in the mile as Shoreham has *now* in feet, it would not prevent the formation of bar. So much for the *identity* of my opinions with those of Mr. Brooks.

Before leaving this branch of the subject, however, it may be well to examine how far *Mr. Brooks's theory will bear testing* by the examples of *Shingle Bars* on the southern coast.

His theory attributes the formation of bars *entirely* to the irregularities of the lower bed, for in page 21, he states, that "an accurate examination of the state of a bar river will exhibit a great irregularity of its surface at low water, in lieu of the river presenting at that period a longitudinal section of succession of inclined planes described in the preceding description of rivers free from a bar." And again, in page 23, "We shall still be able to trace to the same cause the existence of their bars, viz. to the excess of slope which their longitudinal section presents near their embouchure."

Now let us see how far this explanation is applicable to the south-eastern harbours, invested with shingle (such as my Report treated upon), and especially Shoreham Harbour. It is very doubtful to me if Mr. Brooks, or any other engineer, after having calmly and systematically investigated the mode in which shingle travels on the coast, and after examining the mouth of the southern harbours, would be *bold enough* to hazard his reputation by stating, that the irregularities of the beds of the rivers are the causes of the formation of the bars; neither do I think he would give it as his opinion, that if the bed of the river or channel of Shoreham harbour, or any other harbour on the coast, were reduced to the gentle succession of planes that he speaks of, the formation of the bars would be prevented. The fact is, that the condition of the bed of the river has no influence whatever on the shingle travelling and entering the harbour's mouth. (See pages 8, 9, and 10, of my Report, as to the mode the shingle travels). But does Mr. Brooks, on his principle or theory, explain such cases as that of Newhaven harbour on the east of Shoreham?

That this harbour has a very *gentle slope and inclination*, will be seen by reference to what the Commissioners appointed to survey the harbours on the south-eastern coast, have stated respecting it: they say—"The bar is left dry at low-water spring tides, but within the piers there is about two feet water at such times, *and this depth continues uniform for a mile up channel.*" The inclination and slope of Newhaven harbour is not one quarter as great as that of Shoreham Harbour, and notwithstanding this, at times the bar is greater at Newhaven, notwithstanding its immense quantity of backwater, and as stated in p. 39 of my Report, the bar increases rapidly during storms, and diminishes in calms: certainly Mr. Brooks's theory cannot account for this phenomenon.

He would find it difficult to explain what connection the condition of the bed of channels could have with the formation of such bars, when those bars (unlike the Tyne, or the Tees,) are composed, not of materials derived from the channels, but of shingle impelled along the coast by the waves of the ocean.

Again, Littlehampton Harbour (on the west of Shoreham,) has a bed agreeable in every respect to the following language of Mr. Brooks, in explaining his views of "harbours free from bars," (see p. 19 of his book,) viz.,—"A long line of navigable course exists, with an *extremely gentle fall*, or slope of its surface at low-water; the river is in this case in a proper train, its longitudinal section presenting a succession of inclined planes, becoming more and more gentle as they approach the ocean." Now the fall at Littlehampton for a great distance is only seven inches in the mile; and yet it is encumbered with a bar of great magnitude. See further the following extract from the report of the Commissioners appointed to survey the South-eastern harbours. "Littlehampton.—The depth of water in the entrance between the piers is two or three feet below low-water, but a bar extends outside the dicker-work, across the mouth, which rises about two feet above the general surface, and is left dry at low-water. The tide flows generally twenty-five miles up the river, but the backwater thereby afforded proves of little value, in consequence of the narrowness of the channel, and the sluggishness of the stream."

How does Mr. Brooks's theory stand in connection with this harbour, and indeed with any on the coast? How in the name of common sense can he state that I entertain his views and language on bar harbours? If I had embraced Mr. Brooks's notions concerning bar harbours on the southern coast, it must have been in violation of my own convictions, and in direct opposition to all my observations respecting the laws that govern the motion of shingle, and to the utter neglect of all the experiments on the currents, seas, and breakers, that I have made; and as I before stated, there is no more comparison between my engineering views and those of Mr. Brooks on bar harbours, than between light and darkness.

With regard to my alleged admiration of Mr. Brooks's composition, I can only say, that if he claims to himself the exclusive use of certain phrases, such as "treating a symptom," and imagines that no one else can have made use of them without having pirated them from him, he stands a fair chance of being thought "pretty considerably conceited." Mr. Brooks must remember that there are other men and other engineers who can think and write besides himself. So far from Mr. Brooks and myself having used the expression "treating a symptom" in the same sense, it will be seen on re-perusal of the extracts he makes, and the preceding pages of my Report, that the difference is in reality so great, that if we applied Mr. Brooks's theory to the harbour that I am reporting upon, it would only be treating the effect and leaving the cause untouched. You will perceive from the first line in p. 5 of my report, that there was a meeting of the Commissioners on the 4th of February, which I attended, when the question of the bar at the harbour's mouth was fully discussed, the Commissioners at the time being divided in their opinions as to the remedy. To prove my sincerity, and the faith I had in my plans, I offered to accomplish all that I subsequently advised in the report, at my own cost; and if the bar was prevented from forming at the harbour's mouth for five years after the execution of the works proposed, the natural conclusion would be, that the remedy was a *permanent one* (as stated in my Report). At the end of that time, the Commissioners were, if the object were accomplished to their satisfaction, to repay me the money expended with interest. On making this proposition, I was immediately assailed by some of the Commissioners,* with the fact that an immense amount of money had been expended on their own harbour and the harbours of Littlehampton, Newhaven, Rye, Folkestone, and Dover, that Mr. James Walker had spent during the last few years, at the latter port, about £60,000 in attempting the removal of the bar, without effect, and that Mr. Walker was a first-rate authority, being President of the Institution of Civil Engineers, and a very clever man.

It was in allusion to this circumstance that the following observation, embodying the extract to which Mr. Brooks refers, was written, (see p. 16,) viz.—"I cannot, in commencing this subject, refrain from adverting to a very common error, promulgated generally by persons residing on this coast, that because the mouths of their harbours have been subject to bars before they were born and after, that it is a hereditary disease that cannot be removed. It is high time this egregious error was exploded.

"I hope you will duly consider that in these days great strides and progress in advance have been made in science, and it will not be impossible to remove the bar, when it is reflected how many things have been done which were put down as impracticable, but which are now of ordinary adoption." With this fresh upon my mind, and the examination of the documents relating to the before-mentioned harbours, which proved that no less a sum than £300,000 had been

* And *one* Commissioner in particular, who had previously said, "That he did not care *who* the engineer was that proposed to remove the bar, that he was a *madman*, that the bar had been before the harbour's mouth before he was born, and would be there after he was gone."

squandered in very few years on them, I could not wonder that the Commissioners inquired why so little had been done towards improving their harbours, and I candidly answered by stating *my conviction to be*, that those having the disbursement of this vast amount of money had contented themselves with operating upon the effect (just what they would have done if they had adopted Mr. Brooks's theory), and had, in fact, expended their whole force and valuable talents in attempting to remove the bars after they were formed, instead of preventing their deposition in the first instance.

The last of Mr. Brooks's remarks refers to extracts from p. 19 of my Report, and 82 of his own: here we are speaking of different individuals*—he of Mr. Rennie and his works at Newcastle, and I of Mr. Chapman and his works at Shoreham: this will at once be made evident by giving the whole of the passage, of which Mr. Brooks only quotes a part: it is as follows, viz.,—"This fully confirms, or rather explains, that part of Mr. Chapman's report referred to above, and depends entirely on the backwater in removing the bar, and provides no means, nor lays out one farthing, as a provision in preventing the formation of it, and labours hard to attack the effect produced, without even inquiring after the cause.

"There is nothing that gives me greater pain than in the investigation after truth to be obliged to give the proposed mode (here established) of removing the bar, my blank contradiction, and though at the risk of being charged with presumption in setting my humble, but most decided opinion, against that of one who in his lifetime stood so high in his profession as Mr. Chapman, yet the importance to you and the nation at large, of the subject of the formation of bars at your harbour and elsewhere, forces me to encounter most distinctly the arguments advanced, because there is nothing in nature so certain, that the very thing Mr. Chapman recommends towards removing the bar is the true cause of its formation: reference to the harbour will be sufficient to establish this opinion."

Then having set forth the last case here so readily explained, Mr. Brooks thinks that his race is nearly run, and at the conclusion in reality admits, that he does not agree with me on the subject of bar harbours. But, Mr. Editor, just before he drops his "Aaron's Rod," he attempts to give you a blow for your impartial language in reviewing my report. But in this you are not alone: every editor that has hitherto reviewed the report, has been in favour of the principles I have advocated.

The subject of bar harbours being of such vast importance to this great maritime nation, I hope you and your correspondents will in the pages of your Journal pursue the subject.

I am, Sir, yours, &c.,
W. B. PRICHARD.

28, Wilmington Square, London, September, 1843.

INSTITUTION OF CIVIL ENGINEERS.

An Account of the Brick-making at Blechingley Tunnel, during the winter of 1840, *and summer of* 1841. By Frederick Walter Simms, M. Inst. C. E.

As the forming of this part of the Dover Railway was not let by contract, it was necessary to make extensive preparations previously to commencing the work, and amongst these the brick-making department was one of the principal, the whole being under the personal superintendence of the author. The bricks were all made on the surface along the line of the tunnel, the brick-grounds being so arranged on each side of the shafts, that when the bricks were delivered from the kilns and stacked, but little labour was necessary to convey them to the spot, whence they were lowered to the underground works. The mode of manufacture adopted was that of "slop-moulding," in which process the mould is dipped into water previous to its receiving the clay, instead of its being sanded, as is the case in making sandstock bricks; the workmen then throws the clay with some force into the mould, pressing it down with his hands to fill all the cavities, and strikes off the overplus with a stick; an attendant boy, who has previously placed another mould in a water trough by the side of the moulding table, takes the mould just filled, and carries it to the floor, where he carefully drops the brick from the mould on its flat side, and leaves it to dry; by the time he has returned to the moulding table and deposited the empty mould in the water trough, the brick-maker will have filled the other mould, for the boy to convey to the floor, where they are allowed to dry, and are then stacked in readiness for being burned in clamps or kilns. Minute details of the manufacture are then given, the results of which are as follows:

One moulder, one temperer, one wheeler, one carrier boy, an d on picker-up boy, from 2 roods, 14½ perches of land, during 22 weeks, 1 6,10 bricks per week, being 354,200 bricks in the season.

A careful comparison is then made between the two modes of sandstock and slop-moulding, from which it appears that while the production of sandstocks is as 30 to 16 of the slop process, the amount of labour is as 7 to 4, and that the quantity of land required, and the cost of labour per thousand, are nearly the same in both processes. The bricks were all burned in close kilns constructed with soft bricks set in pugged clay, the quantity burned in them at a time varying from 30,000 to 40,000. The fuel employed was that known by the name of the Bell Robson Netherton, or South Hartley coals, and for the purpose of more accurately determining the cost of this element, the author caused the quantity of coals consumed in burning ninety-four kilns of bricks to be carefully noted: this is given in a table accompanying the communication; the average of it is, that 10 cwt. 0 qrs. 8 lbs. of coals were used, in burning each thousand of bricks. The floor of the drying-houses was made of pugged clay about 9 inches thick at the furnace end, and gradually diminishing to 2 inches at the extreme or chimney end, so as to equalize the heat of the floor. The temperature of the interior of these drying-houses, when in full operation, varied from 50° to 70° Fahrenheit. The estimated cost of the bricks delivered at the shafts was £2 1*s.* 10*d.* per thousand; but the actual cost, obtained by dividing the total expenditure by the whole number of bricks made, was only £2 1*s* 6*d.* per thousand, which includes waste and all other expenses that were incurred. The author notices the substitution of Mauritius sugar mats for the ordinary hack-caps made of straw, and that they were durable and serviceable. The paper is accompanied by two drawings showing the elevations and sections of the kilns and drying-houses with their flues.

In answer to questions from several members, Mr. Simms stated that the price of moulding bricks by the slop process was five shillings per thousand; that slop bricks occupied less time in drying than sandstock bricks; that the former kind were full one pound each heavier than the latter, which he attributed to the greater amount of pressure they received when being moulded; for this reason, also, the sandstocks were made somewhat quicker. The price of the ordinary hack-caps made of straw, was four-pence each, and they lasted one season; the Mauritius sugar mats which were substituted for them, cost about one penny each, and would last two seasons.

Mr. Bennett thought that the quantity of bricks which could be produced by each gang of men was underrated, for, at Cowley, the average number of sandstocks moulded was 32,000 per week; while his men very frequently made 37,000, and sometimes they reached as far as 50,000. The space occupied for moulding at Blechingley appeared small; in Mr. Bennett's brick-ground, ten stools occupied twenty acres; this might arise in some degree from more time being allowed for drying in the sandstock process: he believed this to be an advantage; the principal part of the shrinkage took place while drying, previously to being burnt. The total amount of contraction in his bricks was 13-16ths of an inch in 10 inches; but all clays differed in the amount of contraction.

Mr. Farey directed the attention of the meeting to Hunt's improvements on the Marquess of Tweeddale's machine for making bricks; it had not, he believed, yet been brought into general use in England, but it was employed extensively at Hamburgh and other places on the Continent, and was stated to produce stronger and better shaped bricks, of more uniform quality than those made by hand moulding; the process was a kind of intermediate one between slop and sand-moulding; the moulds being wetted as in the former process, while the clay was tempered in a pug-mill, as in the latter process. A very ingenious system of moulding without wetting the clay had recently been introduced by Mr. Prosser, of Birmingham. At present the system was confined to the production of buttons, small tiles, and slabs for painting; but the patentee asserted that the machine could be advantageously used in making bricks. A few had been made which, in burning, only shrunk 1-80th of an inch in 9 inches.

Mr. Bennett said that the Marquess of Tweeddale's machine had not been adopted generally, because of the first cost, and that the necessity for employing horse power, or a steam-engine, for working them, rendered the bricks more expensive than when made by hand.

Mr. Homersham stated that steam or horse power was not indispensable; that Messrs. Simpson and Co. had made several of Hunt's machines for the Tweeddale Brick Company to be worked by manual labour, and that they succeeded perfectly. He found the bricks so produced about one sixth stronger than those made by hand, which he attributed to the degree of pressure to which they were subjected.

* If I may judge from the address given in Mr. Brooks's Treatise, he was not then in the service of the Corporation of Newcastle. Perhaps Mr. Brooks will favour your valuable pages with an account of the improvements (in opposition to the opininions of the late Mr. Rennie,) made under his direction since he has been in the employ of the Corporation, and their effects on the bar, or he may do the community service by forwarding to you for publication his annual Report to the river Committee.

Mr. Simms objected to the use of machinery, chiefly because it would only effect an economy in the moulding, which was but a small part (about one-eight) of the expense of making bricks. The contraction of the bricks varied according to the nature of the clay employed; the moulds used at Blechingley were 10 inches long by 5 inches wide, and 3 inches thick, and the bricks when burned were 9 inches long by 4⅜ in. wide, and 2¾ inches thick. The chemical constitution of different clays, and the relative proportions of alumen and silex contained in them, would be a subject of much interest and practical utility, to be brought before the Institution by some member possessing the necessary chemical knowledge.

Mr. Bennett mentioned the existence of a brick machine invented by Mr. Ainslie, and now working in Scotland; it was, he believed, somewhat cumbrous, and required to be driven by steam power, but he had understood that it produced very good bricks and tiles, but was chiefly employed to make the latter.

In answer to a question from the President, Mr. Simms said that the bricks at Blechingley had been made without any cavity in the top and bottom, in order not to waste the cement in which they were laid. Engineers entertained very opposite opinions as to the utility of the cavity in the bricks.

Mr. Cubitt preferred the bricks having a cavity, if they were to be laid in mortar; with cement it was of less importance.

Mr. Farey believed that when the cement was stronger than the bricks, cavities on the surfaces were desirable, but if the bricks were good, and stronger than the cement, the cavities were not necessary. Mr. Farey exhibited specimens of tiles, &c., made by Mr. Prosser, of Birmingham, and described the process of manufacture. The clay was first dried upon a slip kiln as if for making pottery, then ground to a fine powder, and in that dry state it was subjected to heavy pressure in strong metal moulds: by this means it was reduced to about 1-3rd of its original thickness, but the clay appeared to have contained sufficient moisture to give it cohesion, and the tiles retained the most perfect sharpness at the edges—they were then carried direct to the kiln, and baked in "saggers" or crucibles, without any previous drying, and they did not appear to crack in baking. A brick of the usual dimensions, which was exhibited, had been made by this process from the common brick-earth of Staffordshire, ground fine: it was of a clear red colour, and of homogeneous texture, and the edges were sharp; its weight was 6¾ lbs., and the specific gravity was 2·5. Mr. Farey stated that this brick was not vitrified, but merely baked, and that it had acquired its density from the great pressure used, which was equal to 250 tons.

Mr. Pellatt had seen Mr. Prosser's machine at work, making buttons and other small objects; the ground clay appeared to retain a certain degree of moisture which, combined with the pressure, gave it such tenacity, that on leaving the mould it could be handled and carried direct to the kiln; it was compressed to about one-third of its original thickness. The clay of the Staffordshire potteries contained chiefly silicate of alumine; it was principally valuable for, and was employed in, making "saggers" or crucibles wherein the china was baked. The clay from which the china and crockery-ware was made, was brought from Devonshire, Dorsetshire and Cornwall, and was used with certain mixtures of silex and other substances according to the manufacture.

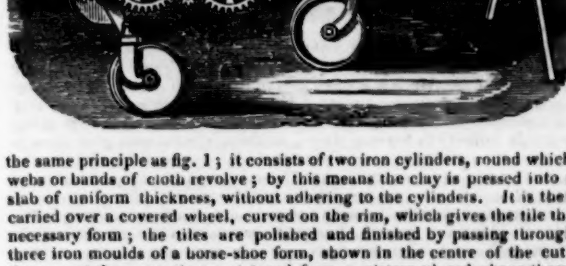
Mr. Blashfield stated that of the specimens of Prosser's manufacture on the table, the small hexagonal tile 3½ inches diameter and 3-8th inch thick, had sustained a pressure of 30 tons, without the edges being crushed; another of the same diameter and 2¼ inches thick, bore 35 tons, and the 9-inch stock brick remained perfect under a pressure of 90 tons: the largest sized slab hitherto produced by the process was 34 inches long by 8 inches wide, and ½ inch thick: but he believed that as soon as the new hydraulic presses were completed, it was Mr. Prosser's intention to make large bricks of varied forms for architectural purposes.

In reply to a question from the President, Mr. Cowper explained that tiles, &c., after being subjected to the pressure, were released by the action of a treddle, which raised the bottom of the mould, and thus brought out the object without injuring its edges.

Mr. Hunt exhibited a model of the brick-making machine, (Fig. 1)

used by him, and described its construction and action. The principal working parts consisted of two cylinders, each covered by an endless web, and so placed as to form the front and back of a hopper, the two sides being iron plates, placed so that when it was filled with tempered clay from the pug-mill, the lower part of the hopper, and consequently the mass of clay within it, had exactly the dimensions of a brick; beneath the hopper, an endless chain traversed simultaneously with the rotation of the cylinders; the pallet boards were laid at given intervals upon the chain, and being thus placed under the hopper and the clay brought down with a slight pressure, a frame with a wire stretched across it, was projected through the mass of clay, cutting off exactly the required thickness of the brick, which was removed at the same moment by the forward movement of the endless chain; this operation was repeated each time that a pallet board came under the hopper.

Mr. Hunt stated that the chief object of the machine, which was worked by hand, was to produce good square compact bricks, of uniform quality, using only a slight pressure. He had found that it was very difficult to dry bricks made by machinery where considerable pressure was employed; because, before the evaporation from the centre clay was completed, the surfaces were overdried and they frequently scaled off. These machines were in operation in several parts of England, producing usually about 1200 bricks per hour, and each machine required two men and three boys to feed it, turn it, and to take off the bricks: the clot moulders were dispensed with, and all the persons employed were common labourers; professed brick-makers were thus not required; he found this of much importance in the contracts which he had taken for making bricks, both in this and in foreign countries. The machine for making tiles (fig. 2) is on



the same principle as fig. 1; it consists of two iron cylinders, round which webs or bands of cloth revolve; by this means the clay is pressed into a slab of uniform thickness, without adhering to the cylinders. It is then carried over a covered wheel, curved on the rim, which gives the tile the necessary form; the tiles are polished and finished by passing through three iron moulds of a horse-shoe form, shown in the centre of the cut; they are at the same time moistened from a cistern placed above them. The tiles are then cut off to such lengths as may be required, and carried away by an endless web, and are placed by boys on the drying shelves. Flat tiles, or soles, are formed in nearly the same manner, being divided into two portions while passing through the moulds; the quantity of clay used for one draining tile being the same as for two soles. In answer to questions from the President, he stated that the density of the bricks could be augmented, but in that case, the time required for drying them must be increased, and frequently artificial means were resorted to, which rendered them more expensive.

Captain Buller inquired whether any advantage was obtained by the production of bricks of such a density as that exhibited by Mr. Prosser; whether builders would not consider them objectionable from their great weight, the difficulty of handling and cutting them, and the increased expense of carriage. He had understood that the lightness of the London bricks, which was chiefly owing to the ashes used in their composition, was considered an advantage, and that they were sufficiently strong for all building purposes.

Mr. Parkes was of opinion that the weight of Prosser's compressed bricks would be objectionable for ordinary purposes, and he did not think that the mortar generally used would adhere to such smooth surfaces as they possessed. The Roman bricks were very dense, but they were small in proportion, and they were used with mortar or cement which had been carefully prepared for a long period before it was used. The Dutch clinkers, which were so very durable, were small in proportion with their density; and the same might be observed of all foreign bricks, some of which were made with great care; for ordinary work he should prefer a brick of a less dense quality than the compressed ones.

Mr. Blashfield explained that Mr. Prosser's bricks could be rendered lighter, by an admixture of ashes or other substances with the clay, if it was considered desirable.

Mr. Newton had recently examined a wall which had been built with very dense bricks, and had twice fallen; the bricks appeared to have absorbed the moisture from the mortar, before it could adhere to their surfaces. He promised to exhibit on a future occasion, some bricks which were brought from the Pyramids of Egypt; they appeared to be composed of sand mixed with chopped straw, and had not much cohesion; yet they were strong enough for the construction of such massive buildings as the Pyramids.

Mr. Hunt said that engineers generally preferred dense bricks, as their works required strength; he had found it advantageous to use mild clay instead of a stronger quality, as compact bricks made from the former, when well-tempered, were better than those of the same density made from the latter.

Mr. Fowler said that the value of bricks depended upon their strength: but he doubted whether density and strength were in this case synonymous; and he thought that bricks of a cellular structure would not only be stronger, but would unite better with the mortar. He thought, however, that Mr. Hunt's machine would prove advantageous, as the bricks produced by it would be of more uniform character than those made by hand moulding.

Mr. Pellatt believed that light bricks were generally porous, and that when they were used for building external walls the moisture soon penetrated; this was not the case with dense bricks, and if they were generally made more compact, thin walls would resist the damp as well as thick ones.

Mr. Cowper believed that for architectural purposes so much density was not absolutely necessary. Houses three stories high had been constructed by the mode of building called 'Pisa" work, which was merely ramming down tempered clay into moulds of the thickness of the walls, and allowing the mass to be dried by the sun as the work proceeded. In countries where the climate was very dry this method succeeded perfectly.

Mr. Braithwaite understood that several kinds of brick were made for the London market, that they were devoted to different uses and were sold at various prices; some qualities were capable of supporting a great amount of pressure and were generally used with cement, while others were almost rotten.

Mr. Bennett said that the principal varieties of bricks were called "malm paviors," "stocks," "grizzles," "places," and "shuffs;" for the first kind the clay was washed and selected with care: the bricks so produced were of superior quality. The other kinds were all made from the same clay merely tempered, the difference between the sorts being produced entirely in burning them; common stocks were good enough for all ordinary building purposes; but the inferior qualities could not be trusted for important works. As to the relative prices of the several sorts, the difference between malm paviors and stocks was fifteen or twenty shillings per thousand; between stocks and places ten shillings; the grizzles obtained a price midway between the two last named, and the shuffs were sold for an inferior price governed by their quality, as they were frequently quite rotten.

Mr. Lowe inquired what object there was in the mixture of "breeze" or ashes, with the clay for making bricks; was it intended to render them less dense, or to assist the combustion, when in the clamp or the kiln?

Mr. Bennett believed that the principal advantage of using a mixture of ashes with the clay was, that it rendered the combustion more regular, when the bricks were burned in open clamps; the sifted breeze was employed for fuel instead of coal, which would otherwise be used for burning in close kilns.

Mr. Hunt explained that the method of making bricks in the vicinity of London, differed from that of almost all other places, because the material employed was not pure clay; it was a substance nearly resembling loam, of a slightly cohesive nature, which would not admit of its being used in the natural state, and burned in close kilns with coal, but that with an admixture of ashes it became sufficiently tenacious to be formed into bricks; the ashes performing the same office as the chopped straw did, in those made by the ancient Egyptians. Of the sixteen hundred millions of bricks made annually in England and Wales, about one-fifth part only was made according to the London method, with a mixture of ashes. As to the density, he did not think that the weight of bricks should be received as an index of their quality; for bricks made by exactly the same process, and equally compact, would be heavier or lighter, as they were made of strong or of mild clay, and yet their strength would be equal.

Mr. Pellatt observed that nearly, if not all argillaceous or aluminous earths were, with certain modifications or admixtures, suited for making bricks. The term silicate of alumine, might include the various earths, whether denominated clay, marl, loam, argile, &c. The best fire bricks were made from native clay, containing alumine combined with a large proportion of silex. The cohesive or plastic property arose from the former, but too much of it rendered the bricks fusible. As most of the common clays contained a large proportion of alumine, with occasionally lime or other fusible substances, a mixture of coarsely pulverised burnt clay, sand, or cinders, became necessary, in order to counteract that tendency. Alumine had a great affinity for silex, as well as iron and sulphuric acid, and the large use of cinders as a mixture with the London clay might be accounted for, not only as it reduced the proportion of alumine to other substances, but because it had a tendency when submitted to heat, to carbonize the sulphates, and to diminish the fusibility of the brick. Bricks made of common clay could not be burnt under the same high temperature as fire bricks, and they contracted much more in burning. All dry substances, which were used to decrease the proportion of alumine, in making bricks or crucibles, were included by the French under the general term of "ciment." The most useful properties of "ciment," when well pugged or kneaded with the clay, were to hasten the drying, and to diminish the contraction, and the consequent risk of breaking in the kiln:—the addition of "ciment" was economical for fire bricks, particularly when they were manufactured at a distance from the mines; the fire clays of Stourbridge, Newcastle, and Glasgow, were found amidst the coal strata; Stourbridge clay was the most esteemed, and when carefully picked, ground, sifted, &c., would bear, for brick-making, two proportions (by weight) of burnt clay or "ciment," to one of native clay. The sagger clay from the Staffordshire potteries was also a fire clay, and was well suited for making tiles or bricks of a compact character, but was probably more liable to be vitrified than the Stourbridge clay. China clay, or the "kaolin" of the Chinese, was decomposed felspar, called in the potteries "Cornwall stone;" the undecomposed felspar was interposed with it, and used by the French and the Chinese as porcelain glaze, the term used for it by the latter was "petuntse." The constituents of "kaolin" were—

According to Dr. Ure:—Silica 52; Alumina 47; Oxide of iron 0.33.

Murray quoted Vauquelin's analysis:—Silex 74; Alumina 16·5; Lime 2; Water 7.

Murray stated Vauquelin's analysis of Hessian Clay to be: Silex 69; Alumina 21 5; Charcoal 1; Oxide of iron 8.

Mr. Parkes believed that, in addition to the ashes giving a cohesive character to the material of which the bricks were composed, they were of advantage in the process of burning, because they enabled the fire to spread gradually from the lower tiers, through the mass in the kiln, without permitting an intense partial heat, such as sometimes occurred where coal alone was used, the effect of which was, that all the bricks around were vitrified, and their surfaces became glazed. He had given some attention to the subject, and had tried experiments, by ascertaining accurately the quantities of ashes and of water which were incorporated with the loam in a certain number of bricks, and had found that the evaporation, during the process of burning, exceeded that of any steam-boiler, as it amounted to as much as 14 lbs. of water by 1 lb. of breeze. The mode of making bricks near London was peculiar to the district, and the workmen did not understand any other method: the blue clay was not used because they did not know how to work it. In a work published by Mr. Aikin, which was a selection from the papers read before the Society of Arts, the subjects of brick-making and pottery were very correctly treated.

Mr. Dickinson observed, that the ashes used in making stock bricks could not supply the place of the straw now discovered in the Egyptian bricks, because the process of burning would have destroyed the straw as it appeared to do the ashes; he had burned bricks extensively in clamps and in kilns, and it appeared to him that the ashes assisted in fluxing the brick-earth, for on breaking a good stock brick, it was always found that the interior appeared to be vitrified, and was extremely hard, and he remarked, that if the ashes worked in with the clay in pugging, either exceeded or fell short of the ascertained proper quantity, the bricks were fragile and less durable.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THIRTEENTH MEETING.

Section A.—Mathematical and Physical Science.—Mr. S. Harris laid before the Physical Section the results of the discussion of the Meteorological Observations made at Plymouth and Devonport, at the request of the Association. The great mass of the results which these observations necessarily involved, had precluded the possibility of completing a full report, such as would be requisite for the pages of the next volume of the Association. The requisite documents are, however, sufficiently complete to insure this report for the next meeting. The first series of observations were those deduced from

Mr. Whewell's Anemometer, by which a result has been arrived at not dissimilar from that laid before the meeting at Manchester, viz., the existence of a sort of trade-wind, or current of air, from south to north, in the place where these observations were made. This was exemplified by large typographical delineations of the aerial currents, by lines proportional to the velocity and direction for given times, laid down for the years 1841 and 1842. Mr. Harris made some observations on the nature and capabilities of this instrument, and the results which might be expected from it, in deducing the great annual movement of the atmosphere. The result of the discussion of the observations with Osler's Anemometer were next brought under consideration, which, being regularly tabulated and discussed, had shown a mean hourly intensity of the wind, tending to follow an order similar, but inverse, to that of the barometer; a major and minor wave occurring in the day, so as to produce two maxima and two minima of intensity: the full discussion of these observations had not yet been effected to a sufficient extent to exhibit all the various relations of the wind required. The remaining observations on pressure and temperature were next considered; and graphical delineations of the mean hourly progress of the temperature, pressure, dew-point, and intensity of the wind, were brought under one point of view in a general diagram.

The Rev. Dr. Scoresby inquired from Mr. Harris how the mean lines, which appeared to be the final result of the observations with the anometers, were obtained?—Mr. Harris replied, that these were merely laid down by the eye, that no deduction was grounded upon them, and that they were placed there merely to give the section a general idea of the mean direction of the great aerial current which passed annually over Plymouth.—Dr. Scoresby suggested, that a mean result might, as he conceived, be very readily and accurately obtained, by laying down each day's work of the machine, something after the manner in which traverse sailing was worked by the masters of ships at sea. To this Mr. Harris assented. Dr. Scoresby stated, that so invariable were the relations between the temperature, pressure, the direction of the wind, and the general state of the weather in the Polar Seas, that when he sailed in them he found he could almost with unerring certainty predict the changes of wind, from north to south and *vice versâ*. He had kept a record of these anticipations for thirty-two days, and twenty-nine of those turned out to be correct.—Mr. Beamish said, that the general result of the anemometer, obtained by Mr. Harris at Plymouth, seemed to indicate an atmospheric current tending towards the west; now this was opposed to a most familiar fact in the county of Cork, namely, that all the trees, particularly near the coast, had a leaning towards the east; indeed, it was well known that the prevailing winds here were westerly.—Mr. Harris replied, that the long continuance of a particular wind did not at all prove that the total atmospheric current set from that quarter; for a single day's violent blowing of a storm from the opposite quarter might be more than sufficient to counterbalance the long-continued but more gentle effect.

Prof. Lloyd availed himself of the opportunity afforded by the present discussion, to read an extract of a letter which he had that morning received from Mr. Osler, describing various improvements which he had recently made in the construction of his anemometer. These improvements consisted, chiefly, in a modification in the form of the vane, whereby its arc of oscillation was reduced in magnitude, and in the dimensions of the pressure plate, by which its indications were rendered more sensible. The writer stated, that he felt much confidence in the performance of his instrument in its present improved form.

"On the Nature and Causes of the Diurnal Oscillations of the Barometer," by G. Hutchison.—In the first part of this paper the author, after stating the leading features of the phenomenon, argued, that the three explanatory suggestions previously advanced relative to its cause, viz., diurnal variations of temperature, diurnal variations in the amount of moisture in the atmosphere, and diurnal variations in the force of the wind, whatever influence they might separately and conjointly have in modifying the extent of the atmospheric tides, and the periods when their maxima and minima are attained, were totally inadequate to account for the broad features of the phenomenon, as exhibited in intertropical climates. The author then ascribed the phenomenon of diurnal atmospheric tides to the ever-varying degrees in which the rotatory and orbital movements act, either in union with, or in opposition to each other, in different latitudes during the course of twenty-four hours, and the different seasons of the year. During night, when the orbital and rotatory movements co-operate more or less in direction, the excess of acquired velocity through space in the orbital direction above the mean of 68,000 miles an hour, must communicate some degree of lateral pressure to the atmosphere in the direction of rotation. On the contrary, during day, when the orbital and rotatory movements act more or less in opposition to each other, the atmosphere must be subject to an equal amount of lateral pressure in the opposite direction of rotation. But when the atmosphere was moving in the orbital direction, with its mean velocity of 68,000 miles an hour, which occurred only at 6 o'clock A.M. and P.M., no lateral pressure could thence result, for the rotatory and orbital movements of the atmosphere, through space, were then equal to, and therefore nullified, or neutralized, its acquired velocity. The theory advanced is also supported by the results obtained from laborious reductions of long-continued observations made in different places, in temperate latitudes, by different philosophers. From these it appears, that even in temperate latitudes the atmospheric tides attain two maxima and two minima annually, the former occurring during spring and autumn, the latter during summer and winter. This, on the supposition of the theory being true, is exactly what ought to take place. In consequence of the rotatory and orbital movements coinciding more directly during night, and being more directly opposed to each other during day, at the equinoxes than at other seasons, it is in accordance with the theory under consideration, that the atmospheric tides should attain their maxima about these periods of the year; and upon the same principle, in consequence of the greater divergence of these forces from exact co-operation with, or opposition to, each other at the summer and winter solstices, than at other seasons, it is also in accordance with our theory, that the atmospheric tides should attain their maxima about these periods of the year.

Mr. Harris inquired, whether the theory laid down by Mr. Hutchison would explain the atmospheric tides in the upper regions of the atmosphere, which were well known to be directly opposite to those lower down, as, for example, those observed and recorded at the Great St. Bernard, by Mr. Forbes.—Mr. Hutchison answered, that they were explained by the theory he had advanced, and that the facts observed by Mr. Forbes at the Great St. Bernard, were among those which he had quoted as proofs of the soundness of the explanation he had ventured to give.—Mr. Harris did not see how the fact, that the hourly oscillations of the barometer, observed at lower latitudes, become negative at higher latitudes, could by any possibility be accounted for by Mr. Hutchison's theory.—Mr. Hutchison admitted, that he could not account for them, and that they constituted the only real difficulty he had met with in explaining by his theory the observed facts.

Mr. Nott, "On a new Electrical Machine, and upon the Electricity of the Atmosphere."—This paper treated at great length of electrical currents and of the atmospheric electricity, by way of a preliminary to the consideration of terrestrial magnetism. The author insisted on the close analogy between the voltaic pile and a magnet. The difference between voltaic and frictional electricity he conceives to be, that the former is *in* the conducting wire, the latter *on* its surface, and therefore decomposed by whatever approaches it. Besides, the voltaic pile exhibits the two electricities, and the current in which they unite; whereas, the ordinary frictional machines develop and maintain but one electricity and no current. Among the novelties presented by the paper, may be mentioned the description of what the author calls the rheo-electric machine, in which both electricities are developed by friction. "It consists of a circular plate of glass, and another of resin, both supported upon a horizontal axis, and set in motion by a winch handle; the rubber of the vitreous plate is connected by a metal rod with the rubber of the resinous one; and the conductor of the latter plate is also connected by a metal rod with that of the former, and thus a complete circuit is formed, as in the voltaic pile. The distribution of the electricity of this instrument is also analogous to that of the pile. For example, the electro-motive disturbance is produced by the plates; the rubber of the vitreous plate is rendered negative, that of the resinous one positive; and the conductors are also in opposite electric states, and their remote extremities are therefore analogous to the poles of the pile. When the conductors are connected by a conjunctive wire, it is natural to suppose that the accumulated electricities flow along its surface in opposite directions, for then an electric current is formed, which permanently deflects the magnetic needle, and the deflection is according to the direction of the current. The direction of motion of this current may be varied at pleasure; for instance, in order to fix our ideas, let us suppose the plates of this instrument and the axis of the conductors to be lying in parallel planes, perpendicular to what is called the magnetic meridian, the conjunctive wire connecting the conductors being bent at right angles, a portion of it will then be in the meridian, and the metal rod connecting the rubbers will be parallel to this portion. If now a magnetic needle be suspended above the conjunctive wire, and the resinous plate, which we will suppose to be placed north of the vitreous one, be connected with the earth, then a current of electricity passes from the resinous plate, and consequently flows along the conjunctive wire from north to south; the needle is then permanently deflected towards the west. If the needle be placed beneath the conjunctive wire, the de-

flection is towards the east. When the vitreous plate is connected with the earth, the current flows from the vitreous plate. and the deflexions are in the opposite directions." In the course of his experiments with this machine, the author found that all the parts of it which were made of brass became, by electrization, highly magnetic, and retained their magnetism for some time. The character of the magnetism thus produced will be understood by conceiving an orthographical projection of this instrument, to be drawn upon a horizontal plane: it will be a parallelogram of which the conjunctive wire will form one side, and the rod connecting the rubbers another: then all the brass parts of one half of this parallelogram, cut off by a diagonal line, will attract the north pole, and all of the other half the south pole. But if immediately after electrization, either pole of the needle be forced into contact with any part of the brass conjunctive wire, it will develope an opposite magnetism to its own, and adhere to the wire as it would to a piece of iron. He also proved that water may be decomposed by the rheo-electric machine, as with the galvanic current. The two electricities, as developed by this machine, appeared to him to be visibly different: the resinous electricity was subject to remarkable changes of colour, according to the state of the atmosphere, and the nature of the exciting body. It also struck him that electricity is radiated in a peculiar manner from magnetized bodies. Combining this observation with a hypothesis respecting the electricity of the globe, viz., that the equatorial parts of the earth are in the resinous (in old language negative) state of electricity, the poles vitreous (positive); while the atmosphere is, in its lower strata, vitreous, and in the upper resinous; the author proceeded to exhibit the phenomena of the aurora borealis by direct experiment. "I procured a globe of steel and magnetized it. It may not be unnecessary to state how this was effected I suspended the globe upon an axis, and by a multiplying wheel and pulley set it in rapid rotation; while rotating I made the magnetizing bars traverse from the equator of the glove to the poles. I then tested it with a proof needle, and found it to be regularly and perfectly magnetized. The next object was to place this magnetic globe in similar electric circumstances to those which I conceived the earth to be in. Regarding that region of the atmosphere immediately over the torrid zone as the principal seat of atmospheric electricity, I conceived, that if I surrounded the globe with a ring that would bear approximately the same proportion to the globe as this region of the atmosphere does to the earth, and electrized them oppositely, that the action of the electricity of the ring upon the air immediately enveloping the globe, would place the latter in nearly similar electric circumstances to those of the earth. If, then, the aurora were an electric phenomenon, that is, a discharge of free electricity, taking place from the pole of the earth, rendering the vortex, which I supposed to be immediately over the pole, luminous, from the great rarefaction of the air within it, and passing over our atmosphere to the upper stratum of the equatorial region, that as I could increase the electric intensity of my artificial terrella as I pleased, an analogous effect would be produced. This result followed with the greatest precision, as I shall now describe. I insulated the ring, and connected it with the resinous conductor of the rheo-electric machine. I also insulated the globe, and connected one of its poles with the vitreous conductor, and placed it so that its equator was surrounded by the ring. These bodies being electrized differently, and at a very short distance from one another, one would expect that a discharge would have taken place between them; instead of this, they at once re-acted upon one another, so that the exterior of the ring being resinous, the interior became vitreous; the equator of the globe resinous, and both its poles highly vitreous; and a truly beautiful and luminous discharge took place from the unconnected pole. The state of the atmosphere has a remarkable effect upon the appearance of this discharge. One evening that the atmosphere was very dense, it had the appearance of a ring of light, the upper part of which was very brilliant, and the under part, towards the globe, was comparatively dark, just as we see at the bottom of ignited vapour; and indeed a vapour of some kind seemed to be ascending from the globe; above the ring, all round the axis, were foliated diverging flames, one behind the other. When the atmosphere is very dry, it has merely the appearance of a beautiful electric brush. If the globe be moved towards any point of the interior of the ring, a discharge takes place in the line of shortest distance between them, and then there is a partial intermission of the auroral light. This experiment seems to point out the true cause of the aurora borealis."

This paper gave rise to a most animated but desultory conversation, in which the President Dr. Robinson, Dr. Scoresby, Dr. Green, and Mr. Snow Harris took part. In the course of this discussion, several questions were asked tending to elucidate the construction and peculiarities of action of the rheo-electrical machine as well as Mr. Nott's views. Mr. Harris then stated that he was about to publish in the *Nautical Magazine*, the observed facts connected with more than 300 thunder-storms, from which he thought it would amply appear that thunder-storms were connected with, and in some manner caused by, opposing and violent currents of wind. That the wind, after blowing for some time from one quarter, changed, and at this crisis, first a calm, and then a flurry and confusion of the wind, blowing from every point of the compass, ushered in the change. It was in this confused state that the rapid deposition of vapour seemed to take place, torrents of water pouring down, and sometimes hail and even large masses of ice, as in the late thunder-storm at Cambridge, by which, as the Dean of Ely had informed him, that immense destruction of property had taken place, the hail breaking even strong plate-glass.

Prof. Lloyd made a short communication, on the method of Graphical Representation, as applied to Physical Results. It is well known, that if a series of ordinates be taken to denote the observed values of any physical quantities, the corresponding abscissæ denoting the respective values of the variable upon which it depends, the course of the first variable, at intermediate points, may be represented by drawing a curve through the extremities of the ordinates of observation, the exactness of the representation depending on the shortness of the intervals. The observed values of the ordinates, however, being subject to the errors of observation, it is manifest that their extremities are not necessarily points of the representative curve; and the object of the author was to inquire whether, and under what circumstances, *other* points could be substituted for those of immediate *observation*, the former being connected with the latter by known relations. Such a course is usually resorted to, when the intervals of observation are small, and the errors considerable, the curve being, in such cases, drawn (*not through*, but) *among* the points furnished by observation, allowing a weight in proportion to their number. The validity of this process appears to depend on two principles—viz. 1. That the positive and negative errors are equally probable; and 2. the assumption that the function represented is not subject to abrupt changes. It is obvious, however, that its applicability will depend upon the relation in any particular case, which subsists between the intervals of the successive ordinates and their probable errors; and it is important to know what that relation is. The points connected with those of observation by the simplest relations, are those obtained by bisecting the interval between each successive pair, or taking the arithmetical mean both of the ordinates and abscissæ. It is very easy to express, in this case, the relation sought.

Sir W. Hamilton inquired whether the curve, so corrected by Prof. Lloyd, would not, by a continuation of the process, gradually approach to a straight line, and at length end by becoming one, as the first and last points were alone left unchanged during the process. Prof. Lloyd replied in the negative; as the number of points was not diminished during the process.

Sir W. Hamilton 'On a Problem in the Calculus of Differences.'—The author here offered a solution of a curious and important problem, which had exhausted the analytical resources of Laplace, who arrived at an equivalent transformation, but by a much less simple analysis.

'On the Correction to be applied for Moisture to the Barometric Formula,' by J. Apjohn, M.D—If the atmosphere were of one uniform temperature throughout, destitute of moisture, and the intensity of gravity were also constant, it is well known that the difference of the altitudes of any two points in the atmosphere would be represented correctly by the formula $D = m \times \log.\frac{p}{p'}$, m being a constant quantity, and p and p' being the respective pressures at the upper and lower stations, as measured by the barometer, or in any other way. The conditions, however, which lead to this simple expression, are in nature never fulfilled; for it will seldom happen that the temperature of either station is 32°, and the atmosphere always includes a greater or less amount of aqueous vapour. A correction for temperature has been long applied, by augmenting the approximate height, or $m \times \log.\frac{p}{p'}$, by the amount that a column of air of this length would expand, if raised from 32° to $\frac{t+\theta}{2}$, t being the temperature of the lower, and θ that of the upper extremity of the aerial column,—by which the expression becomes $D = m \times \log.\frac{p}{p'}\left(1 \times \frac{\left(\frac{t+\theta}{2} - 32\right)}{493}\right)$. Such is, I believe, a correct account of the present form of the barometric formula; at least, when we neglect the correction for variation of gravity, which is, however, so minute as to be in general safely negligible. The pressure of moist-

ure in the air must obviously exercise some disturbing effect upon this formula; but though this has been generally admitted by those who have turned their attention to the subject, I am not aware that any attempt at estimating its exact amount has been as yet made; and as the correction for moisture is frequently of considerable magnitude, and may, in my opinion, be applied with as much accuracy as that for temperature, I have taken the liberty of occupying for a few moments the time of the Section with an explanation of the method which it has occurred to me to devise, and with which, from some trials I have made of it, I feel every reason to be satisfied. Let p be the pressure, and t the temperature of the air at the lower station, t'' the dew point of the air, and f the force of the included vapour; and let p', θ, θ'' and F'' represent the corresponding quantities at the upper station. This being understood, a little consideration will suffice to show that the presence of the aqueous vapour produces upon the formula a twofold deranging effect. It augments the value of p and p' beyond what they would be in dry air; and it produces an elongation of the column of air between the two stations, additional to that which results from the excess of its mean temperature over 32°, or the freezing point. The first of these is obviated, or, in other words, the correction for it is made, by substituting for p and p' in the approximate formula, $p - f''$ and $p' - F''$, by which it becomes $D = m \times \log. \frac{p - f''}{p' - F''}$. Having thus eliminated the effects of the tension of aqueous vapour upon the pressures, we have next to estimate the conjoint influence of it and temperature in elongating the pillar of air between the two stations. The theory of mixed gases and vapours enables us to do this, provided we can assign proper mean values to the temperature, the pressure, and the force of vapour of the aerial column in question. The mean temperature is usually taken as $\frac{t + \theta}{2}$; and this must be very nearly its true value. For the same reason the mean force of the vapour may be set down as $\frac{f'' + F''}{2}$; and let us assume the mean value belonging to the pressure as $\frac{p + p'}{2}$. Now, volume v, of dry air at 32°, under a pressure p, if raised to a temperature t', becomes $v \times \frac{461 + t''}{493}$; and if saturated with vapour at this temperature, the tension of such vapour being f'', will become $v \times \frac{461 + t''}{493} \times \frac{p}{p - f''}$. This is the volume of the air when raised to t'', and saturated at this temperature with vapour. And if this volume of air have its temperature farther raised, we shall say to t, then its bulk will be represented by the expression $v \times \frac{461 + t''}{493} \times \frac{p}{p - f''} \times \frac{461 + t}{461 + t''} = v \times \frac{461 + t}{493} \times \frac{p}{p - f''}$. Substituting then in this expression, instead of v, the value of the length of the column of air between the stations, supposed dry, and at 32°, viz. $m \times \log. \frac{p - f''}{p' - F''}$ and for p, t, and f'', their proper mean values as already explained, the barometric formula finally becomes $D = m \times \log. \frac{p - f''}{p' - F''} \times \frac{461 \pm \frac{1}{2}(t + \theta)}{493} \times \frac{\frac{1}{2}(p + f'' + p' + F'')}{\frac{1}{2}(p + f'' + p' + F'') - \frac{3}{8}(f'' + F'')}$. I may add here, that the correction for moisture is far from being insignificant in its amount, as may be seen by the following example. Let us suppose that, when the approximate height corrected for temperature amounts to 2,700 feet (a height reached by several of our Irish mountains), the mean value of the pressure to be used in the final factor of the formula, is 27·3, and of the force of vapour, ·3 of an inch, then the elongation of the aerial column resulting from moisture, is 3-270 = 1-90th of 2,700 = 30 feet. It will, of course, have been observed, that the correction for aqueous vapour differs from that for temperature in the circumstance of being always positive; and this coincides perfectly with the observation I have had frequent occasion of making, viz., that heights calculated by the formula in general use, are all appreciably less than the truth. I may, in conclusion, observe, that in assuming,—with the view of calculating the expansion produced by moisture,—that the pressure to be employed is the arithmetic mean of the corrected pressures got by observation at the two stations, I am quite aware that I am assigning to it but an approximate value. An exact expression for the pressure to be employed admits of being investigated; but its introduction into the formula, while it would give this latter complexity of form, and thus render it less suited for practical use, would conduct to results not appreciably different from those given by the more simple method just explained.

The President briefly pointed out the practical importance of this correction, arising from the extensive use now made of the barometer in geodesical operations, and the uncertainties and discrepancies in its results, which had hitherto been so baffling, but which this correction seemed to afford a prospect of removing.—Prof. Lloyd remarked that Laplace was aware of the necessity of some correction being, in general, requisite to be made in the barometric formula, and had increased the co-efficient from ·00375 to ·004, which, no doubt, would occasionally give an approach to the correct result; but this correction, so ably brought under the notice of the Section by Dr. Apjohn, was the first attempt at a universally applicable correction.—Dr. Apjohn remarked that Laplace's increase of the co-efficient could only give the result correct in one particular hygrometric state of the air, while in every other it must be erroneous.

Mr. Scott Russell then read the concluding Report of a series of observations on the Tides of the Frith of Forth, and of the East Coast of Scotland—These observations extended over several seasons, and no complete report had been hitherto presented, as the observations of each former season had only shown the necessity of further extending the observations. The observations of the first season had proved the existence of certain anomalous tides, which had not formerly been accurately examined, and proved that these anomalies were more extensive than was at first conceived. Next season the observations were more widely extended, so as to comprise the whole phenomenon, including many adjacent places, to which the same anomalies were traced; and thus the general nature and extent of the phenomena were determined with accuracy and precision, and reported to the last Meeting. But it was found that great differences of opinion existed with reference to the cause of these ascertained phenomena, and rendered it obvious that the observations required to be extended still further, in time and extent, in order to settle conclusively the questions which had arisen out of the former inquiries. But this last series, from their extent and completeness, had now been so fully examined and discussed, as to afford ample means of deciding on the nature of the phenomena, and determining their origin. Simultaneous observations had been made at nearly twenty stations on the east of Scotland, from Newcastle and Shields to Inverness, and as many as 2,000 observations a-day registered and discussed. The results of these were exhibited in the tables and diagrams accompanying the Report: and the result of the whole had been to elucidate, in a remarkable manner, the mechanism which propagates along our shores and rivers the great ocean-wave, which carries from one place to another the successive phenomena of the tides—in such a manner as could not have been attained by any system of observation less extensive than that which had been adopted. It is pretty generally known that the phenomena of the tides with reference to their generating cause, the influence of the mass of the sun and of the moon in the various relations of distance and direction of these luminaries, have recently been examined with great success, in a series of researches carried on, first by Mr. Lubbock, and then by Mr. Whewell, partly with the co-operation of this society. By means of their labours, we are now enabled to predict, with unlooked-for accuracy, the time of high-water, and the height of the tide in many of the harbours of Great Britain. But many of the local phenomena of tides remained unaccounted for, and these had been the object of a special series of researches, of which the present formed a part; the object being to determine in what way the conformation of the shores, and of the bottom of the sea, and the forms of the channels of rivers and friths, affect the phenomena of the tidal wave. The rivers Dee and Clyde had been formerly examined with this view. To these were now added the Forth, and the northern shores of the German Ocean. The manner in which these observations were conducted, is not the usual one, of noting down simply the hour at which high water occurs, and then the hour of low water, along with the height at which the water stands at these times. Such a method had been found quite inadequate to the purposes for which such observations are required, and, indeed, he thought it of importance that all tide observations should, if possible, be made in the manner he was now about to describe, especially all tide observations made for scientific purposes. This plan was, to carry on simultaneously at the places examined, a series of continuous observations, every five minutes night and day, by successive observers, without intermission, for the period of a month, or of several months, as might be required. Printed forms were sent to all the stations, and in them, the observers simply noted down every five minutes, the height of the tide on a graduated scale placed before him. Every day at noon all these papers were sent by post to the central station, and immediately on their arrival, the papers

of the different stations were compared, and their observations laid down on paper, so as to give a graphical representation to the eye of all the observations, by means of which, they were at once verified and compared with great facility. From the examination of these tide-waves thus laid down, certain characters of the tide-wave peculiar to each locality had been discovered. As in the former observations of the Clyde and the Dee, it had been found in this series, that the form and dimensions of a channel produce important changes in the form of the tide-wave. Where the sea was deep, and the shore open and abrupt, the form of the tide-wave was symmetrical, and of the form predicted by Laplace, where he says, that in rising and falling, the water covers in equal times equal arcs of a vertical circle. This is the form of the ocean tide-wave; but, on approaching a shallow shore, and travelling along a shelving coast, the tide-wave undergoes two changes—its summit becomes displaced forwards in time, its horizontal chords become dislocated, and the wave ceases to be symmetrical. This peculiar dislocation and displacement are characteristic of a littoral tide, and in the case of running streams, the currents still further affect the tide-wave, and give to it a peculiar distortion, characteristic of fluvial tides. To these were further added the exaggeration and elevation of the tide, by means of narrow channels. All these phenomena were fully proved by the present series of observations. The author of this paper also considers it to have been fully established by the observations on the Frith of Forth, that there exists on the eastern coast, satisfactory evidence of the presence of a second tide-wave in that part of the German Ocean, and that the southern tide-wave, a day older than the northern tide-wave, sensibly affects the phenomena of that part of the coast. To this he attributes the double tides of the Frith of Forth, the nature of which he fully explained. Regarding these double tides, various theories had been formed—and there were various ways in which such tides might happen, whenever tide-waves arrive by different paths in different times. But this kind of double tide was, in this case, only to be explained by the method he had adopted, and which removed the difficulties in which the subject had formerly been involved. He then proceeded to explain the mode of discussion which had been adopted. It was the semi-diurnal inequality, so accurately examined by Mr. Whewell, which enabled us to decide on the ages of two tides. If the two tides which appeared together, presented opposite inequalities both in time and in height, regularly alternating, varying with the moon's declination, disappearing with it, and re-appearing with it, and following it regularly, without regard to other simultaneous changes of a different period, then it became plain that no other inference could be drawn than that which he had mentioned; when, further, he had proceeded to treat these tides as compounded of two successive tides, one due to a transit 12 h. 24 m. later than the other, and had used for this purpose two simple river tides super-imposed at a distance, in time corresponding to that at which the northern and southern tides could enter the Frith, he had obtained a close representation of the double tides of the Frith of Forth; when these two methods of examination ended in the same conclusion, he conceived that it had obtained a very high degree of probability. By means of these observations, tide-tables had been formed, which were designed to afford a more accurate means of predicting the local tides of the east coast of Scotland than any we now possessed.

Dr. Robinson and the President put several questions to Mr. Russell, for the purpose of eliciting the facts more clearly.—Lord Mountcashel inquired whether Mr. Russell had observed and accounted for any of the tidal phenomena which were denominated bores, and described one which he had witnessed in the River Seine, the rapidity of which far outstripped that of the steam-boat in which they were proceeding.—Mr. Russell said that he had frequently observed this phenomenon, and described the bore of the River Dee, and of the Solway Frith. He then briefly accounted for it on the principle of the tidal wave coming with enormous rapidity from deep water, where it was freely propagated, into shoal water, where the upper part, retaining its velocity less impaired while the bottom was retarded, it toppled over, at length, breaking in its rapid onward course. —Captain Larcom observed, that the Ordnance Survey would contain a very full account of the tidal phenomena along the coast of Ireland. Captain Larcom hoped before long to lay before the Association the result of the observations made on the coast of Ireland in the course of the Ordnance Survey. Gauges were established at different stations, and observations have been made every five minutes during the course of three lunations. The direct object of them was to obtain data for the plane of mean sea level; but while the observations (which are now in course of reduction), are likely to decide this, they also give much valuable information as to irregularities like that just mentioned. He might mention that in Lough Swilly the spring tide high water was eight feet higher than in Lough Foyle.

"Experiments to prove that all Bodies are in some degree Inelastic, and a Proposed Law for estimating the Deficiency," by E. Hodgkinson, F.R.S.—Mr. Hodgkinson said it was a principle generally acknowledged in the present day, and employed by those who have written on the subject of elasticity, that, when bodies are acted upon by forces tending to elongate or compress them in a small degree, the changes produced are in proportion to those forces; and that equal extensions and compressions are produced by equal forces. That this principle is true, so long as the change produced in bodies is very small, is not to be doubted; and as regards *extensions*, it is the basis of the early investigations of Jacques Bernouilli on the elastic curve; of Hooke, who was its author (Theory of Springs, Phil. Trans., 1666); Mariotte, Leibnitz (De Resistentia Solidorum, 1684). With respect to elasticity, it was adopted in the profound inquiries of Euler on the strength of columns, which were corroborated by Lagrange (Berlin Memoirs); and with respect both to *extensions* and *compressions*, it forms the basis of the calculations on the strength and elasticity of bodies in the principal theoretical and practical works on mechanics of the present day; as the Mécanique of Poisson, and the works of Whewell, &c.—the practical treatises of Navier, Poncelet, Tredgold, Barlow, Moseley, &c. He hoped, however, to convince the Section that this principle does not operate *alone* in the resistance of bodies subjected to tension, or to compression, or to both. He hoped, too to show the law which the element, not considered by writers, nor generally known to exist, is subject to. This element is a defect of elasticity, or a set, to which all bodies made to undergo a change of form, however small, seem to be liable. The defect here mentioned was known to exist only when the body had been strained with a considerable force, or such as to be equal to one-third, or upwards, of the breaking weight. But the experiments which he should adduce would show that the defect commences with the smallest changes of form, and is increased according to the square of the extension, or compression, or of the weight. Thus, if e represent the extension or compression which the strained body had undergone, and $a\,e$ the force which would have produced that extension or compression if the body had been perfectly elastic, the real force necessary to produce this change, e, will be less than the former by a quantity, $b\,e^2$, representing the defect of elasticity. Hence the force required to produce a change, e, is $a\,e - b\,e^2$, where a and b are constant quantities. He had found this law to obtain when the change produced in the body arose from extension or compression alone, but when the change arose both from extension and compression, as in the flexure of a rectangular body, the force of a fibre was to that due to perfect elasticity, as $a\,x - b\,x^2$ to $a\,x$; or it was equal to $a\,x - b\,x^2$, where x was the weight applied, and a b constant quantities, as before. In proof of these statements, Mr. Hodgkinson mentioned that having remarked, in his experiments made for the British Association on the subject of hot and cold blast iron, that the elasticity of bars broken transversely was injured much earlier than was generally assumed, he paid particular attention to this circumstance in his future experiments, and had bars so formed that he could separate the elasticity of extension from that of compression; by these bars, which were very long and of small depth, he perceived that one-fiftieth or one-eightieth of the breaking weight was sufficient to injure the elasticity. He mentioned the matter to his friend, Mr. Fairbairn (who was associated with him in the inquiry), soon after he had made the discovery; and Mr. Fairbairn's subsequent experiments made to determine the strength of rectangular bars of iron, from all parts of the kingdom, were conducted in the same manner as Mr. Hodgkinson's had been; the deflexion and quantity of set, or defect of elasticity, from each weight being always observed. Mr. Fairbairn's experiments were on bars cast one inch square and five feet long, and were made with the utmost care; Mr. Hodgkinson has, therefore, adopted their results with respect to the "set," and taking means both from Mr. Fairbairn's results, and his own, on the same sort of bars, he has sought for the relation between the weights and the mean sets from those weights, these sets being the deflexions or deviations from the original form of the bar, after the weights have been removed. To ascertain the relation above, Mr. Hodgkinson had curves described from the results of the experiments, making the sets the abscissæ, and the weights the ordinates; and the similarity in appearance of these curves to the common parabola, led him carefully to examine whether they were not in reality represented by that curve. The examination was successful—the parabola was the curve; and the mean results of the observed sets, together with the calculated ones, from equal additions of weight, from 56 to 448 lb., derived from 44 kinds of cast iron, and from 90 to 100 experiments, were as follows,—

Weights	56	112	168	224	280	336	392	448
Mean sets	.003	.013	.026	.047	.069	.102	.136	.197
Computed sets (parabolic)	.003	.012	.027	.047	.072	.102	.138	.181

Mr. Hodgkinson made experiments on stone, timber and wrought iron, and observed the quantity of set in all. These different materials, when the results from them were constructed, all gave the form of the parabola, though less perfectly than in cast iron, as the experiments on them were but few. It appears, from the above-stated experiments, and others that were made, that the sets produced in bodies, are as the squares of the weights applied. Hence, there is no weight, however small, that will not produce a set and permanent change in a body; all bodies, when bent, have the arrangement of their particles altered to the centre; and when bodies, as the axles of railway carriages, are alternately bent, first one way and then the opposite, at every revolution, we may expect that a total change in the arrangement of their particles will ensue. It appears, too, from the results of these experiments, that all calculations hitherto made, on the strength and elasticity of bodies, have been only approximations. Mr. Hodgkinson stated, that he laid the results of this communication before a meeting of the Literary and Philosophical Society of Manchester a short time ago, soon after he had made the discovery which it contains. In the prosecution of the experiments he had received every assistance which the works of his friend, Mr. Fairbairn, could supply; and Mr. Robert Rawson had kindly assisted him in the reduction and arrangement of the results of the experiments.

This communication gave rise to much conversation, in which the President, Prof. Lloyd, Dr. Robinson, and other persons joined, and in which all agreed, that these experimental inquiries were of the utmost importance in supplying a solid foundation for the speculations of the mathematical investigator in this most difficult branch of physical inquiry. Dr. Robinson also inquired, if Mr Hodgkinson had observed whether the molecular structure of the bodies, on which he had experimented, was altered in any manner, and if so, how did the change take place, during the progress of the experiments?—Mr. Hodgkinson replied, that he had no means of determining this point satisfactorily, but he had no doubt, that matter, when subjected to strain, long before it broke, had its molecular structure permanently deranged. He exemplified this by the axles of locomotive engines, which, as they turned round, had the parts that were extended and compressed, successively underneath and above; and after this action had been continued for a long period, they were found to become of a kind of crystalline structure, internally, and of course were much impaired in strength.—Prof. Stevelly said, that the forces to which they were subjected were in kind, though not in degree, something like the alternate bending back and forward of a piece of wire, under which it at length broke.

REVIEW.

The Inventor's Manual: a Familiar and Practical Treatise on the Law of Patents for Inventions. By J. T. Danson, and G. Drysdale Demsey. London: 1843. P. 94.

The object of this work, as the Authors inform us, is—"to furnish to inventors and others interested in patent property, such an exposition of that system as may enable them, without entering into details merely technical, to acquire a knowledge of the nature and extent of the rights it confers, and the remedies provided for their infringement." We are much mistaken, however, if the intentions of the authors were in fact confined to the exposition of the rights of patent property, for if such had been their object, without "details merely technical," a book of nearly one hundred pages would not have been required; one tenth of the space would have been more than ample. The intentions of the authors seem to have been two-fold—first, to raise doubts and fears in the minds of inventors, as to the safety of property in patents, and then to recommend an immediate application to some person capable of protecting them. Where is the man possessing any property in patents who can read the following passage without a secret anticipation that he will sooner or later lose it, from his inability to protect himself by the law:—

"More patents have been impeached and declared void, on the ground of defective specification, than from any other cause. Indeed it has been estimated, that not one half of the large number of these documents annually enrolled would bear the test of a trial at law; and to those who are best acquainted with the subject, this estimate does not appear to be a very erroneous one."

It might have been expected that after this statement, alarming enough, if true, to frighten every one interested in patent property, that some mode of avoiding the insecurity would have been suggested, but no such information is given. What is the use of alarming men by telling them they are in great danger, without showing them some means by which they may with prudence and personal exertion escape? What is the use of "a Familiar and Practical Treatise on the Law of Patents for Inventions," which informs the patentee that not one half the patents can be protected by law, and yet does not point out the means by which his danger may be escaped. But there was a reason for the assertion, and the same reason accounts for the publication of the work. "We need scarcely say that the most likely mode of effecting this object (the proper preparation of a specification), will be to entrust the preparation of it to a thoroughly competent person, and to place at his disposal all the information on the subject which the inventor himself possesses." Now this is, we imagine, just what inventors do, or suppose they do. But if the results are such as our authors state, there is but little inducement to continue the practice, and "a familiar practical Treatise on the law of Patents" would be of more use than the patent agents desire.

This book was no doubt intended to be a respectable advertisement for its authors, and those who expect in it such information as would enable them to prepare their own specifications will be disappointed. It contains some facts of moment, and may be read with interest, but it is not a guide to inventors in obtaining patents, but to the office of a patent agent.

DISCOVERIES AND INVENTIONS.

PAYNE'S PROCESS FOR THE PRESERVATION OF TIMBER.

A few months since we alluded to Mr. Payne's process for the preservation of timber, and promised to give a further account of the invention at an early opportunity. The process consists in filling the pores of vegetable matter with metallic substances. This is accomplished by first impregnating wood, in an exhausted receiver or tank, with a metallic oxide, and then decomposing the compound body under great atmospheric pressure by a re-agent, so as to leave the substance employed in a metallic state. By this process timber may be prepared with any substance, whether metallic, alkaline, or earthy, and in an exceedingly short period of time. Mr. Payne's process is a sort of artificial fossilization. He does that in a few hours, we might almost say minutes, which is also done by natural agencies, but in lengthened periods of time. The process is not only unobjectionable, but we might say perfect, and the question therefore is, whether timber can be protected from decay or destruction by the infusion of mineral substances into its structure.

All the varieties of timber commonly employed for building purposes in this country are subject to decay from eremacausis or rot, occasioned by various conditions, and under a multitude of circumstances. To prevent this, numerous schemes have been introduced during the last twenty years. Many of these have been tried, and have been found utterly useless. We think that better success will attend Mr. Payne's invention.

To protect timber from destruction by insects has been found a still more difficult task than to preserve it from rot. Mr. Bethell's is the only process that has been found in any degree successful in sea water. The chivalric secretary of the Kyan Company has been within the last few months valiantly defending the pretensions of corrosive sublimate, and if he had not been already defeated, we should have been inclined to place before our readers the results of a few experiments, which no sophistry could overthrow. We cannot, however, resist the temptation of quoting a passage from Mr. Mallett's masterly paper on the action of air and water on cast and wrought iron and steel, read in May last before the Institution of Civil Engineers. "The kyanised oak boxes," he says, "two inches in thickness, in which the specimens were immersed in Kingston harbour, were eaten through in about two years by the *Limnoria terebrans*." When it is considered, that hydraulic works must under all circumstances be performed with a considerable outlay of capital, and cannot be restored without more than ordinary expense, the importance of detecting that which will not protect the timber employed is scarcely less useful to the profession and public, than to discover that which will preserve it. Mr. Payne's process is yet to be tested by experiment.

There are numerous purposes to which wood prepared with noxious materials cannot be applied, so that, even if they gave durability, they would do so at the expense of usefulness. This objection cannot be urged against Mr. Payne's process, nor will its introduction be in any

degree retarded by the emission of an unpleasant odour. It is a further recommendation, that timber preserved by the introduction of metal in its pores is incombustible.

PATENT ELASTIC PAVEMENT.

A Company has been recently formed to carry out an invention called the patent elastic pavement. This material consists of caoutchouc and other substances, so combined as to form a strong but elastic body. It can of course be obtained in blocks, of any size and form that may be required. It is particularly recommended by the proprietors of the patent for stables, but is reported to be equally suitable for many other purposes. It is said to be "devoid of smell, is laid down cold, in blocks like foot tiles, varying from one-eighth to three inches in thickness, hermetically cemented together at the edges, so that the whole forms one piece, without a joint, and may be obtained of such gravity as the situation to which it is applied shall render desirable." We have a hand specimen before us, and can speak of it as a material likely to fulfil the promise of the patentee, but it yet remains to be proved whether it will be found to answer the purposes required in practice. We shall watch its adoption, and report upon it according to circumstances.

JEFFREY'S MARINE GLUE.

This novel and in many respects important invention has established its claims to attention by repeated trials, some of which have come under our own notice. In ship building it is already extensively employed, and will, in all probability, ultimately supersede the present system of caulking. It is not only recommended by the circumstance, that it forms a perfectly water-tight joint, but may be used at a considerable saving of expense, compared with the cost of the modes now in use. The carpenter and joiner are not yet aware of the great value of this invention, and of the saving that would be secured by its use, but it will require time to introduce it into all the purposes for which it is suited. An attempt has also been made to use it for the protection of timber from the attacks of the marine insects which haunt our coasts, and rapidly destroy our works. Whether it will be found effective for this purpose, must be proved by experiment; but of its usefulness in timber constructions there can be no doubt. We have before us a design for a timber bridge, in which the engineers propose to employ it extensively.

FRENCH RAILWAY OF THE NORTH.

On the 18th and 19th inst., the Minister of Public Works visited the works now in progress upon the line of the Railway of the North, between Paris and Clermont (Oise). On the 18th, the minister was on the ground as early as six in the morning, near St. Lazare, where he was met by the Marquis de la Morélie, Councillor of the Prefecture of the Seine, and performing par interim the functions of prefect. M. Oufroy de Bréville, engineer in chief of the 1st division, who was summoned to show the minister the works under his direction, was present, along with M. Reynaud, the engineer of the works about Paris. Some arrangements had to be made relative to the viaduct for entering Paris, which were explained to the minister. From thence the party repaired to St. Denis, where the railway will cross the canal by a skew bridge, constructed on the plan of the Pont de Carrousel, the first stone of which was laid by the minister on this occasion. From St. Denis, the minister repaired to Enghein, and traversed the line from thence to Pontoise, where the Oise is crossed by a stone bridge, the piers of which are already above the level of the water. Upon this part of the line, Mr. Sherwood, who has been much engaged in railways in Great Britain, is the contractor: he has an immense plant, and employs many thousand workmen, some hundreds of whom are English: these are principally employed in the earthwork. The workmen celebrated the arrival of the minister by firing several mines. From Pontoise, the minister followed the valley of the Oise as far as Beaumont, which the party reached in the evening of the 18th.

On the 19th, the minister proceeded to Creil and Clermont, where it was feared at first that some very expensive cutting would be required, but which the engineers have found means to avoid.

From Paris to Clermont, the line is 82 kilometres (about 53 miles) in length. Upon the whole of this extent, both the earthwork and works of construction are so far advanced, that they can easily be completed before the end of the year, with the exception of the bridge of Pontoise, which cannot be finished before the spring of 1844. In applauding the activity displayed by the engineers and contractors in the construction of this line, we cannot help regretting that the grant for it was not made in the course of the last session; we might then have hoped to see the first section opened in the course of the ensuing summer; but as it is, a whole year has been lost on this most important line.—*Journal des Chemins de Fer.*

INTENDED FACADE OF THE BRITISH MUSEUM.

TO THE EDITOR.

Sir,

The *Art Union* and the *Athenæum* seem to be the only publications that have raised any sort of inquiry as to the new façades of the British Museum; but surely the matter is one which fairly comes under cognizance of the "Architect," and calls for notice without loss of time. Let us at least have an opportunity of learning beforehand what the design really is; the more, as it proceeds from one who has not earned our confidence by his other works, numerous as they are. Sir R. Smirke may be a very great genius as a mere builder, or among mere builders, but among architects a dullard. Nevertheless he is, it seems, to be entrusted with the execution of a work that ought to be made an exemplar of refined taste, and to show Grecian architecture in the utmost luxuriance of which it is susceptible, and that at a time when we are made to believe that both the Government and the public have begun to take very great interest in all matters relating to art.

Smirke himself may have most excellent reasons for not calling attention to the classical beauties of his design by exhibiting any model, drawing, or lithograph of it, yet the public have on their part reasons fully as urgent for being let into the secret.

I remain, Sir,
Your obedient Servant,
PHILO.

THE HYDRAULIC BELT.

Several of our correspondents have made inquiries concerning the Hydraulic Belt. The following information will sufficiently answer the questions that have been proposed. It was invented by Mr. Hall, and is manufactured by Mr. Charles Robinson of Pimlico, late Bramah and Robinson. This machine would raise water at the short lift of 12 feet for draining, but can scarcely be recommended for that purpose. It has hitherto been applied to depths from 50 to 150 feet. For short lifts the common pump is cheaper. The belt delivers as much, indeed more water than the other pumps with the same power, and at 100 feet and upwards it is much cheaper and more simple, being only a band of woollen stuff revolving on a roller at the top of the well, and on another in the water at the bottom. It may be worked by animal or steam power, according to the depth of the well, and the quantity of water required in a given time.

PROFESSOR DONALDSON'S LECTURES ON ARCHITECTURE.

Professor Donaldson's Lectures on Architecture, for the session 1843-44, will commence at the London University on the 16th of October. It would not, we believe, have been possible to have found in the metropolis any person so well suited for this chair as the gentleman who holds it: his extensive reading, practical acquaintance with works, urbanity of manners, and not least of all, the respect in which he is held by the profession, unite to distinguish Mr. Donaldson as the man above all others suited for the Professorship of Architecture. During the past season he was eminently successful, and if the youths who are educating for the profession of Architecture in London are really in earnest in their pursuits, they will fill his class room for the ensuing session.